TCT 通测检测
TESTING CENTRE TECHNOLOGY

TEST REPORT

FCC ID: 2AWLP-LPD10-11

Product: LUME PAD

Model No.: LPD-10W

Additional Model No.: LPD-11W

Trade Mark: N/A

Report No.: TCT200527E002

Issued Date: Jun. 15, 2020

Issued for:

Leia, Inc

2440 Sand Hill Road, STE 100, Menlo Park, California 94025, United States

Issued By:

Shenzhen Tongce Testing Lab.
1B/F., Building 1, Yibaolai Industrial Park, Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, China
TEL: +86-755-27673339
FAX: +86-755-27673332

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1. Test Certification

Product:	LUME PAD
Model No.:	LPD-10W
Additional Model No.:	LPD-11W
Trade Mark:	**N/A**
Applicant:	Leia, Inc
Address:	2440 Sand Hill Road, STE 100, Menlo Park, California 94025, United States
Manufacturer:	Leia, Inc
Address:	2440 Sand Hill Road, STE 100, Menlo Park, California 94025, United States
Date of Test:	May 28, 2020 – Jun. 12, 2020
Applicable Standards:	FCC CFR Title 47 Part 15 Subpart C Section 15.247 FCC KDB 558074 D01 15.247 Meas Guidance v05r02 ANSI C63.10:2013

The above equipment has been tested by Shenzhen Tongce Testing Lab. and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product/system, which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Tested By: Brews Xu **Date:** ***Jun. 12, 2020***

Brews Xu

Reviewed By: Beryl Zhao **Date:** ***Jun. 15, 2020***

Beryl Zhao

Approved By: Tomsin **Date:** ***Jun. 15, 2020***

Tomsin

2. Test Result Summary

Requirement	CFR 47 Section	Result
Antenna Requirement	§15.203/§15.247 (c)	PASS
AC Power Line Conducted Emission	§15.207	PASS
Conducted Peak Output Power	§15.247 (b)(1)	PASS
20dB Occupied Bandwidth	§15.247 (a)(1)	PASS
Carrier Frequencies Separation	§15.247 (a)(1)	PASS
Hopping Channel Number	§15.247 (a)(1)	PASS
Dwell Time	§15.247 (a)(1)	PASS
Radiated Emission	§15.205/§15.209	PASS
Band Edge	§15.247(d)	PASS

Note:

1. PASS: Test item meets the requirement.

2. Fail: Test item does not meet the requirement.

3. N/A: Test case does not apply to the test object.

4. The test result judgment is decided by the limit of test standard.

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3. EUT Description

Product:	LUME PAD
Model No.:	LPD-10W
Additional Model No.:	LPD-11W
Trade Mark:	**N/A**
Bluetooth Version:	V5.0 (This report is for BDR+EDR)
Operation Frequency:	2402MHz~2480MHz
Transfer Rate:	1/2/3 Mbits/s
Number of Channel:	79
Modulation Type:	GFSK, π/4-DQPSK, 8DPSK
Modulation Technology:	FHSS
Antenna Type:	Internal Antenna
Antenna Gain:	1.96dBi
Power Supply:	Rechargeable Li-ion Battery DC 3.85V
AC adapter:	Adapter Information: Model: A138A-120150U-US4 Input: AC 100-240V, 50/60Hz, 0.5A Output: DC 5V, 3A/DC 9V, 2A/DC 12V, 1.5A
Remark:	All models above are identical in interior structure, electrical circuits and components, and just LPD-10W with rear camera, LPD-11W without rear camera.

Note: *The antenna gain listed in this report is provided by applicant, and the test laboratory is not responsible for this parameter.*

Operation Frequency each of channel for GFSK, π/4-DQPSK, 8DPSK

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402MHz	20	2422MHz	40	2442MHz	60	2462MHz
1	2403MHz	21	2423MHz	41	2443MHz	61	2463MHz
…	…	…	…	…	…	…	…
10	2412MHz	30	2432MHz	50	2452MHz	70	2472MHz
11	2413MHz	31	2433MHz	51	2453MHz	71	2473MHz
…	…	…	…	…	…	…	…
18	2420MHz	38	2440MHz	58	2460MHz	78	2480MHz
19	2421MHz	39	2441MHz	59	2461MHz	-	
Remark: Channel 0, 39 &78 have been tested for GFSK, π/4-DQPSK, 8DPSK modulation mode.							

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4. General Information

4.1. Test environment and mode

Operating Environment:		
Condition	Conducted Emission	Radiated Emission
Temperature:	25.0 °C	25.0 °C
Humidity:	55 % RH	55 % RH
Atmospheric Pressure:	1010 mbar	1010 mbar
Test Mode:		
Engineering mode:	Keep the EUT in continuous transmitting by select channel and modulations with Fully-charged battery	
The sample was placed 0.8m & 1.5m for the measurement below & above 1GHz above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case(Z axis) are shown in Test Results of the following pages. DH1 DH3 DH5 all have been tested , only worse case DH1 is reported.		

4.2. Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Equipment	Model No.	Serial No.	FCC ID	Trade Name
/	/	/	/	/

Note:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.

2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

3. For conducted measurements (Output Power, 20dB Occupied Bandwidth, Carrier Frequencies Separation, Hopping Channel Number, Dwell Time, Spurious Emissions), the antenna of EUT is connected to the test equipment via temporary antenna connector, the antenna connector is soldered on the antenna port of EUT, and the temporary antenna connector is listed in the Test Instruments.

5. Facilities and Accreditations

5.1. Facilities

The test facility is recognized, certified, or accredited by the following organizations:

- FCC - Registration No.: 645098
  Shenzhen Tongce Testing Lab
  The 3m Semi-anechoic chamber has been registered and fully described in a report with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files.
- IC - Registration No.: 10668A-1
  The 3m Semi-anechoic chamber of Shenzhen TCT Testing Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing

5.2. Location

Shenzhen Tongce Testing Lab.
Address: 1B/F., Building 1, Yibaolai Industrial Park, Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, China
Tel: 86-755-27673339

5.3. Measurement Uncertainty

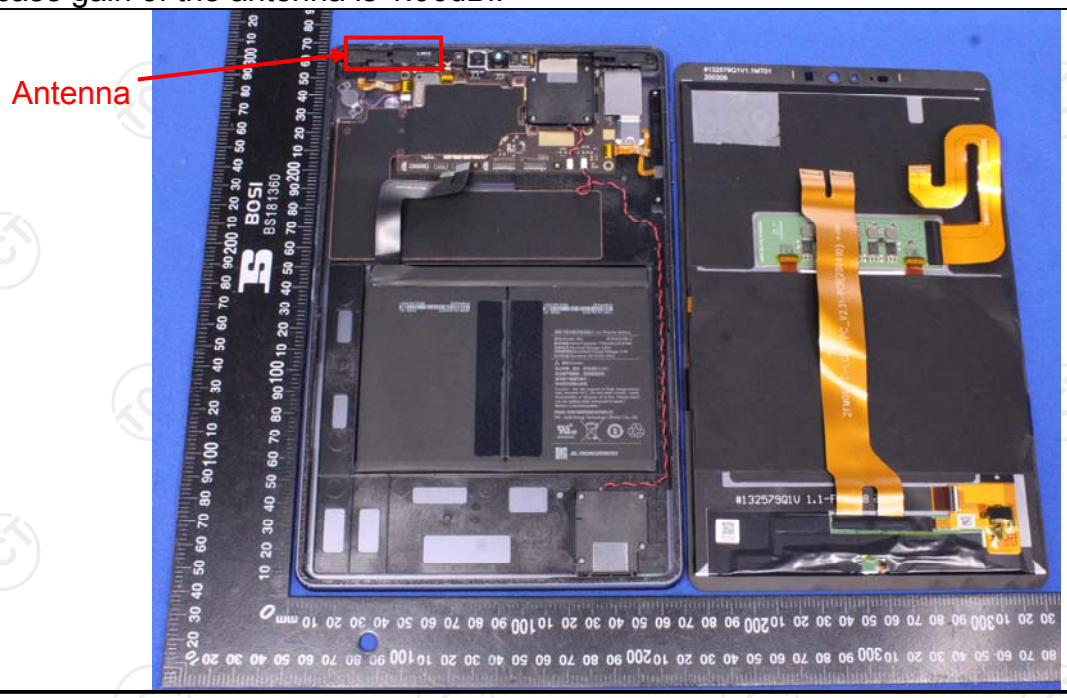
The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 %.

No.	Item	MU
1	Conducted Emission	±2.56dB
2	RF power, conducted	±0.12dB
3	Spurious emissions, conducted	±0.11dB
4	All emissions, radiated(<1G)	±3.92dB
5	All emissions, radiated(>1G)	±4.28dB
6	Temperature	±0.1°C
7	Humidity	±1.0%

6. Test Results and Measurement Data

6.1. Antenna requirement

Standard requirement:	FCC Part15 C Section 15.203 /247(c)
15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 15.247(c) (1)(i) requirement: (i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.	
E.U.T Antenna:	
The Bluetooth antenna is internal antenna which permanently attached, and the best case gain of the antenna is 1.96dBi.	



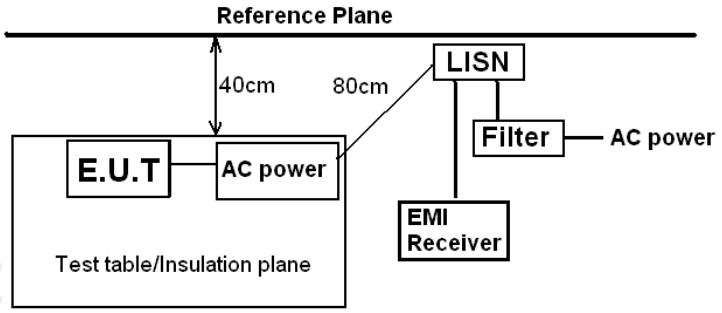
6.2. Conducted Emission

6.2.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.207
Test Method:	ANSI C63.10:2013
Frequency Range:	150 kHz to 30 MHz
Receiver setup:	RBW=9 kHz, VBW=30 kHz, Sweep time=auto
Limits:	

Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

Test Setup:



Remark:
E.U.T: Equipment Under Test
LISN: Line Impedence Stabilization Network
Test table height=0.8m

Test Mode: Refer to item 4.1

Test Procedure:

1. The E.U.T is connected to an adapter through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm/50uH coupling impedance for the measuring equipment.
2. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs).
3. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10:2013 on conducted measurement.

Test Result: PASS

6.2.2. Test Instruments

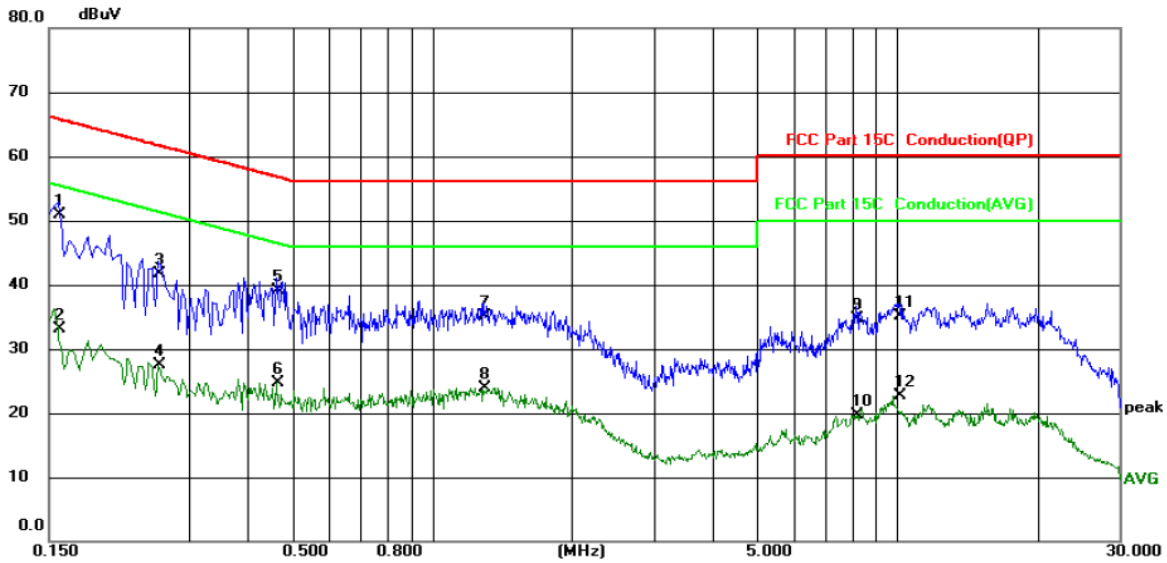
Conducted Emission Shielding Room Test Site (843)				
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Due**
Test Receiver	R&S	ESPI	101402	Jul. 29, 2020
LISN	Schwarzbeck	NSLK 8126	8126453	Sep. 11, 2020
Coax cable (9KHz-30MHz)	TCT	CE-05	N/A	Sep. 08, 2020
EMI Test Software	Shurple Technology	EZ-EMC	N/A	N/A

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.2.3. Test data

Please refer to following diagram for individual

Conducted Emission on Line Terminal of the power line (150 kHz to 30MHz)



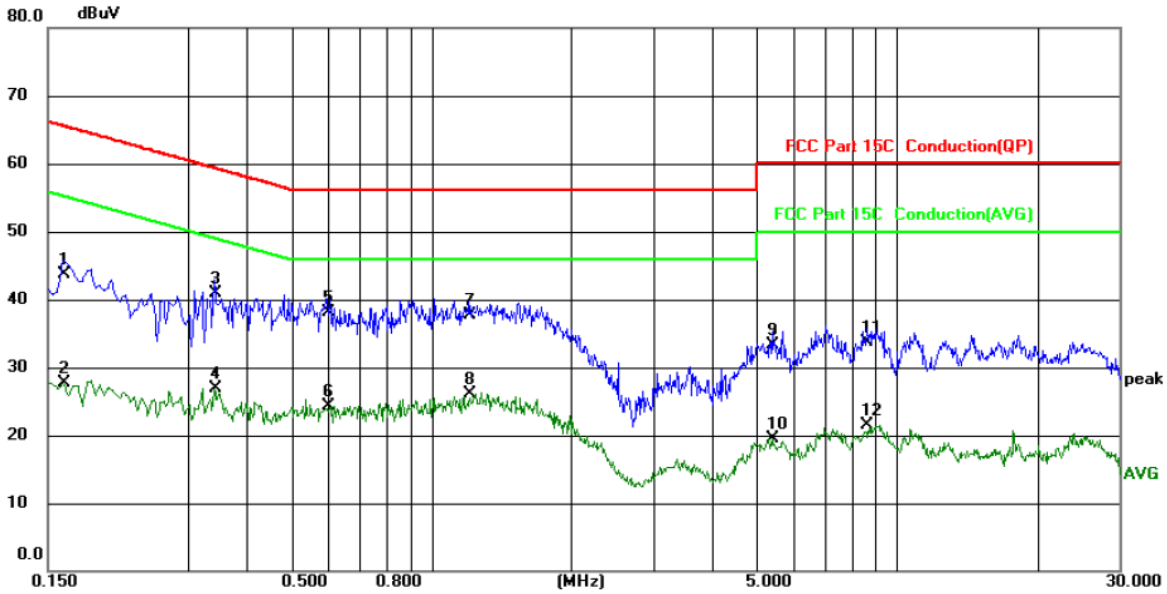
Site	Phase: *L1*	Temperature:	25 (C)
Limit: FCC Part 15C Conduction(QP)	Power: AC 120V/60Hz	Humidity:	55 %RH

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1580	40.74	10.22	50.96	65.57	-14.61	QP	
2		0.1580	22.95	10.22	33.17	55.57	-22.40	AVG	
3		0.2580	31.44	10.23	41.67	61.50	-19.83	QP	
4		0.2580	17.22	10.23	27.45	51.50	-24.05	AVG	
5		0.4660	28.82	10.22	39.04	56.58	-17.54	QP	
6		0.4660	14.39	10.22	24.61	46.58	-21.97	AVG	
7		1.2900	24.76	10.39	35.15	56.00	-20.85	QP	
8		1.2900	13.57	10.39	23.96	46.00	-22.04	AVG	
9		8.1820	24.13	10.53	34.66	60.00	-25.34	QP	
10		8.1820	9.17	10.53	19.70	50.00	-30.30	AVG	
11		10.0780	24.57	10.57	35.14	60.00	-24.86	QP	
12		10.0780	12.13	10.57	22.70	50.00	-27.30	AVG	

Note:

Freq. = Emission frequency in MHz
Reading level (dBµV) = Receiver reading
Corr. Factor (dB) = LISN factor + Cable loss
Measurement (dBµV) = Reading level (dBµV) + Corr. Factor (dB)
Limit (dBµV) = Limit stated in standard
Margin (dB) = Measurement (dBµV) – Limits (dBµV)
Q.P. =Quasi-Peak
AVG =average
** is meaning the worst frequency has been tested in the frequency range 150 kHz to 30MHz.*

Conducted Emission on Neutral Terminal of the power line (150 kHz to 30MHz)



Site		Phase:	N	Temperature:	25 (C)
Limit: FCC Part 15C Conduction(QP)		Power:	AC 120V/60Hz	Humidity:	55 %RH

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1620	33.66	10.12	43.78	65.36	-21.58	QP	
2		0.1620	17.53	10.12	27.65	55.36	-27.71	AVG	
3		0.3420	30.68	10.13	40.81	59.15	-18.34	QP	
4		0.3420	16.81	10.13	26.94	49.15	-22.21	AVG	
5	*	0.5980	28.03	10.13	38.16	56.00	-17.84	QP	
6		0.5980	14.16	10.13	24.29	46.00	-21.71	AVG	
7		1.2059	27.60	10.12	37.72	56.00	-18.28	QP	
8		1.2059	16.02	10.12	26.14	46.00	-19.86	AVG	
9		5.4140	23.26	10.13	33.39	60.00	-26.61	QP	
10		5.4140	9.35	10.13	19.48	50.00	-30.52	AVG	
11		8.6180	23.63	10.14	33.77	60.00	-26.23	QP	
12		8.6180	11.29	10.14	21.43	50.00	-28.57	AVG	

Note1:

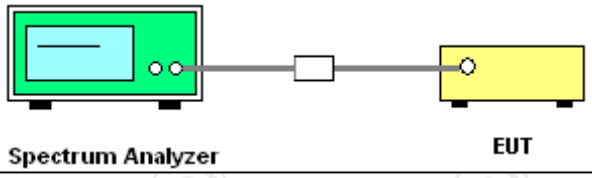
Freq. = Emission frequency in MHz
Reading level (dBµV) = Receiver reading
Corr. Factor (dB) = LISN factor + Cable loss
Measurement (dBµV) = Reading level (dBµV) + Corr. Factor (dB)
Limit (dBµV) = Limit stated in standard
Margin (dB) = Measurement (dBµV) – Limits (dBµV)
Q.P. =Quasi-Peak AVG =average
** is meaning the worst frequency has been tested in the frequency range 150 kHz to 30MHz.*

Note2:

Measurements were conducted in all three channels (high, middle, low) and three modulation (GFSK, Pi/4 DQPSK, 8DPSK), and the worst case Mode (Highest channel and GFSK) was submitted only.

6.3. Conducted Output Power

6.3.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (b)(1)
Test Method:	KDB 558074 D01 v05r02
Limit:	Section 15.247 (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts.
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	Use the following spectrum analyzer settings: Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel RBW > the 20 dB bandwidth of the emission being measured VBW ≥ RBW Sweep = auto Detector function = peak Trace = max hold Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission.
Test Result:	PASS

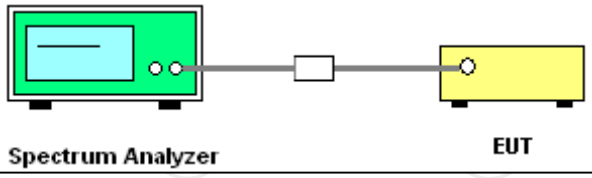
6.3.2. Test Instruments

Name	Manufacturer	Model No.	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	N9020A	MY49100619	Sep. 11, 2020
4 Ch. Simultaneous Sampling 14 Bits 2 MS/s	Agilent	U2531A	N/A	Sep. 08, 2020
Combiner Box	Ascentest	AT890-RFB	N/A	Sep. 08, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.4. 20dB Occupy Bandwidth

6.4.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	KDB 558074 D01 v05r02
Limit:	N/A
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Use the following spectrum analyzer settings for 20dB Bandwidth measurement. Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel; 1%≤RBW≤5% of the 20 dB bandwidth; VBW≥3RBW; Sweep = auto; Detector function = peak; Trace = max hold. 4. Measure and record the results in the test report.
Test Result:	PASS

Note: *DH1 DH3 DH5 all have been tested, only worst case DH1 is reported.*

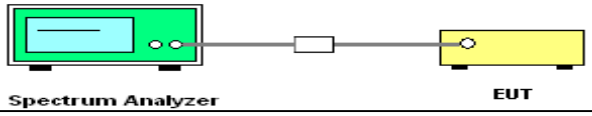
6.4.2. Test Instruments

Name	Manufacturer	Model No.	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	N9020A	MY49100619	Sep. 11, 2020
4 Ch. Simultaneous Sampling 14 Bits 2 MS/s	Agilent	U2531A	N/A	Sep. 08, 2020
Combiner Box	Ascentest	AT890-RFB	N/A	Sep. 08, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.5. Carrier Frequencies Separation

6.5.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	KDB 558074 D01 v05r02
Limit:	Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
Test Setup:	
Test Mode:	Hopping mode
Test Procedure:	1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Enable the EUT hopping function. 4. Use the following spectrum analyzer settings: Span = wide enough to capture the peaks of two adjacent channels; RBW is set to approximately 30% of the channel spacing, adjust as necessary to best identify the center of each individual channel; VBW≥RBW; Sweep = auto; Detector function = peak; Trace = max hold. 5. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Record the value in report.
Test Result:	PASS

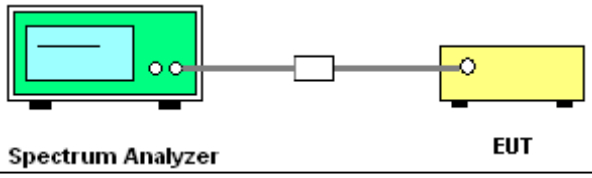
6.5.2. Test Instruments

Name	Manufacturer	Model No.	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	N9020A	MY49100619	Sep. 11, 2020
4 Ch. Simultaneous Sampling 14 Bits 2 MS/s	Agilent	U2531A	N/A	Sep. 08, 2020
Combiner Box	Ascentest	AT890-RFB	N/A	Sep. 08, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.6. Hopping Channel Number

6.6.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	KDB 558074 D01 v05r02
Limit:	Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.
Test Setup:	
Test Mode:	Hopping mode
Test Procedure:	1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Enable the EUT hopping function. 4. Use the following spectrum analyzer settings: Span = the frequency band of operation; set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller; VBW≥RBW; Sweep = auto; Detector function = peak; Trace = max hold. 5. The number of hopping frequency used is defined as the number of total channel. 6. Record the measurement data in report.
Test Result:	PASS

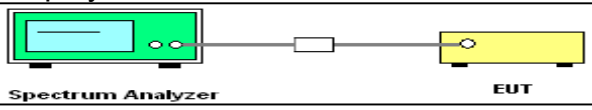
6.6.2. Test Instruments

Name	Manufacturer	Model No.	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	N9020A	MY49100619	Sep. 11, 2020
4 Ch. Simultaneous Sampling 14 Bits 2 MS/s	Agilent	U2531A	N/A	Sep. 08, 2020
Combiner Box	Ascentest	AT890-RFB	N/A	Sep. 08, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.7. Dwell Time

6.7.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (a)(1)
Test Method:	KDB 558074 D01 v05r02
Limit:	The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.
Test Setup:	
Test Mode:	Hopping mode
Test Procedure:	1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Enable the EUT hopping function. 4. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel; RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel; VBW≥RBW; Sweep = as necessary to capture the entire dwell time per hopping channel; Detector function = peak; Trace = max hold. 5. Measure and record the results in the test report.
Test Result:	PASS

6.7.2. Test Instruments

Name	Manufacturer	Model No.	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	N9020A	MY49100619	Sep. 11, 2020
4 Ch. Simultaneous Sampling 14 Bits 2 MS/s	Agilent	U2531A	N/A	Sep. 08, 2020
Combiner Box	Ascentest	AT890-RFB	N/A	Sep. 08, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.8. Pseudorandom Frequency Hopping Sequence

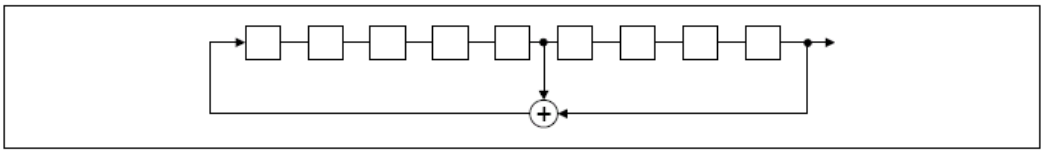
Test Requirement:	FCC Part15 C Section 15.247 (a)(1) requirement:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
Alternatively. Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

EUT Pseudorandom Frequency Hopping Sequence

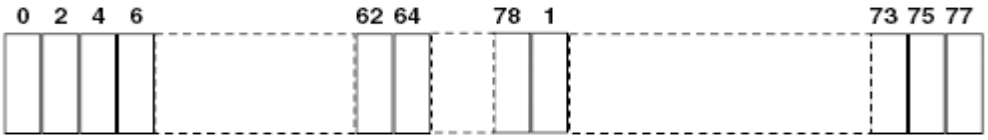
The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: 2^9 -1 = 511 bits
- Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

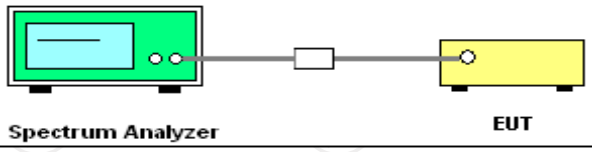
An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.
The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

6.9. Conducted Band Edge Measurement

6.9.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (d)
Test Method:	KDB 558074 D01 v05r02
Limit:	In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. Set to the maximum power setting and enable the EUT transmit continuously. 2. Set RBW = 100 kHz (≥1% span=10MHz), VBW = 300 kHz (≥RBW). Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used. 3. Enable hopping function of the EUT and then repeat step 2 and 3. 4. Measure and record the results in the test report.
Test Result:	PASS

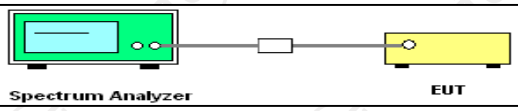
6.9.2. Test Instruments

Name	Manufacturer	Model No.	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	N9020A	MY49100619	Sep. 11, 2020
4 Ch. Simultaneous Sampling 14 Bits 2 MS/s	Agilent	U2531A	N/A	Sep. 08, 2020
Combiner Box	Ascentest	AT890-RFB	N/A	Sep. 08, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.10. Conducted Spurious Emission Measurement

6.10.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (d)
Test Method:	KDB 558074 D01 v05r02
Limit:	In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Set RBW = 100 kHz, VBW = 300kHz, scan up through 10th harmonic. All harmonics / spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW. 4. Measure and record the results in the test report. 5. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.
Test Result:	PASS

6.10.2. Test Instruments

Name	Manufacturer	Model No.	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	N9020A	MY49100619	Sep. 11, 2020
4 Ch. Simultaneous Sampling 14 Bits 2 MS/s	Agilent	U2531A	N/A	Sep. 08, 2020
Combiner Box	Ascentest	AT890-RFB	N/A	Sep. 08, 2020

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.11. Radiated Spurious Emission Measurement

6.11.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.209
Test Method:	ANSI C63.10:2013
Frequency Range:	9 kHz to 25 GHz
Measurement Distance:	3 m
Antenna Polarization:	Horizontal & Vertical

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
9kHz- 150kHz	Quasi-peak	200Hz	1kHz	Quasi-peak Value
150kHz-30MHz	Quasi-peak	9kHz	30kHz	Quasi-peak Value
30MHz-1GHz	Quasi-peak	120KHz	300KHz	Quasi-peak Value
Above 1GHz	Peak	1MHz	3MHz	Peak Value
	Peak	1MHz	10Hz	Average Value

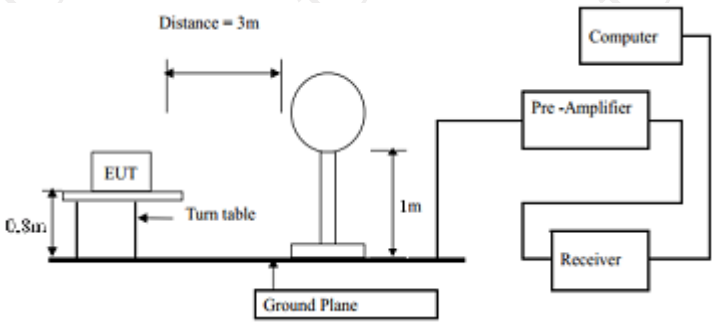
Limit:

Frequency	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009-0.490	2400/F(KHz)	300
0.490-1.705	24000/F(KHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

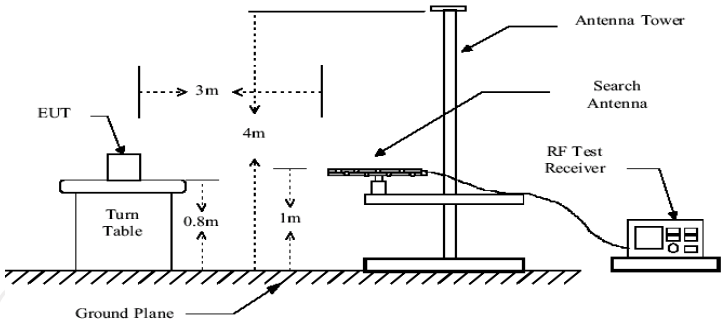
Frequency	Field Strength (microvolts/meter)	Measurement Distance (meters)	Detector
Above 1GHz	500	3	Average
	5000	3	Peak

Test setup:

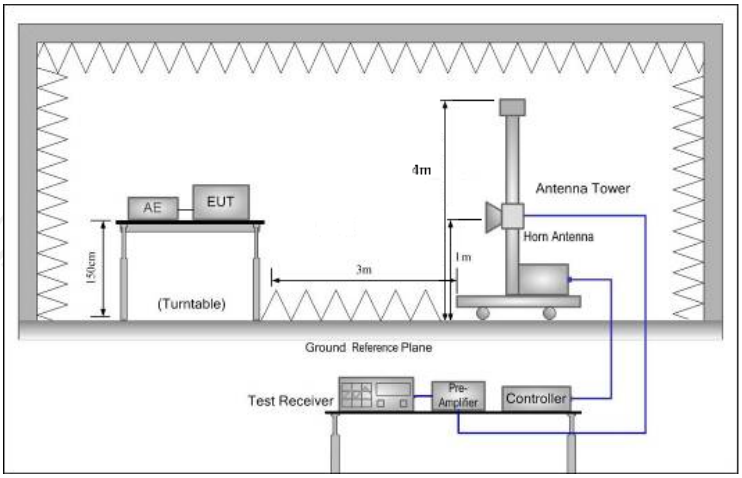
For radiated emissions below 30MHz



30MHz to 1GHz



Above 1GHz



Test Mode:	Transmitting mode with modulation
Test Procedure:	1. The testing follows the guidelines in Spurious Radiated Emissions of ANSI C63.10:2013 Measurement Guidelines. 2. For the radiated emission test below 1GHz: The EUT was placed on a turntable with 0.8 meter above ground. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high PASS filter are used for the test in order to get better signal level. For the radiated emission test above 1GHz: Place the measurement antenna on a turntable with 1.5 meter above ground, which is away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission

	and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane. 3. Set to the maximum power setting and enable the EUT transmit continuously. 4. Use the following spectrum analyzer settings: (1) Span shall wide enough to fully capture the emission being measured; (2) Set RBW=120 kHz for f < 1 GHz, RBW=1MHz for f>1GHz ; VBW≥RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak (3) For average measurement: use duty cycle correction factor method per 15.35(c). Duty cycle = On time/100 milliseconds On time =N1*L1+N2*L2+...+Nn-1*LNn-1+Nn*Ln Where N1 is number of type 1 pulses, L1 is length of type 1 pulses, etc. Average Emission Level = Peak Emission Level + 20*log(Duty cycle) Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
Test results:	PASS

6.11.2. Test Instruments

Radiated Emission Test Site (966)				
Name of Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Due**
Test Receiver	ROHDE&SCHWARZ	ESIB7	100197	Jul. 29, 2020
Spectrum Analyzer	ROHDE&SCHWARZ	FSQ40	200061	Sep. 11, 2020
Pre-amplifier	EM Electronics Corporation CO.,LTD	EM30265	07032613	Sep. 08, 2020
Pre-amplifier	HP	8447D	2727A05017	Sep. 08, 2020
Loop antenna	ZHINAN	ZN30900A	12024	Oct. 27, 2020
Broadband Antenna	Schwarzbeck	VULB9163	340	Sep. 06, 2020
Horn Antenna	Schwarzbeck	BBHA 9120D	631	Sep. 06, 2020
Horn Antenna	A-INFO	LB-180400-KF	J211020657	Sep. 06, 2020
Antenna Mast	Keleto	RE-AM	N/A	N/A
Coax cable (9KHz-40GHz)	TCT	RE-high-02	N/A	Sep. 08, 2020
Coax cable (9KHz-40GHz)	TCT	RE-high-04	N/A	Sep. 08, 2020
EMI Test Software	Shurple Technology	EZ-EMC	N/A	N/A

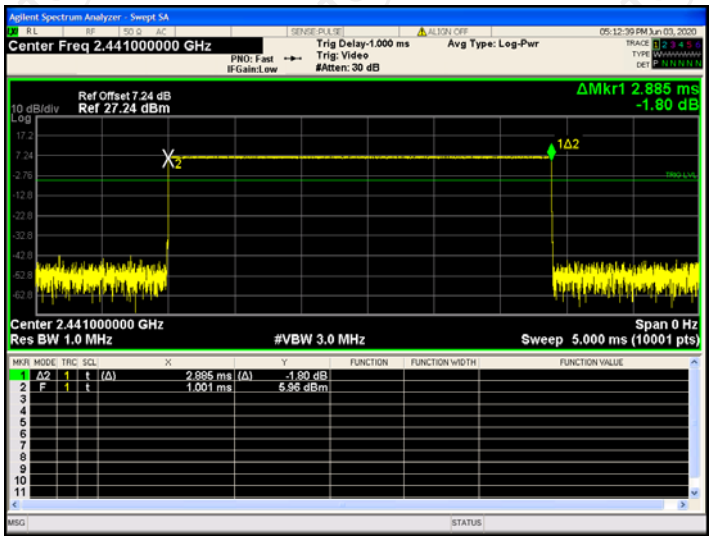
Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

Hotline: 400-6611-140 Tel: 86-755-27673339 Fax: 86-755-27673332 http://www.tct-lab.com

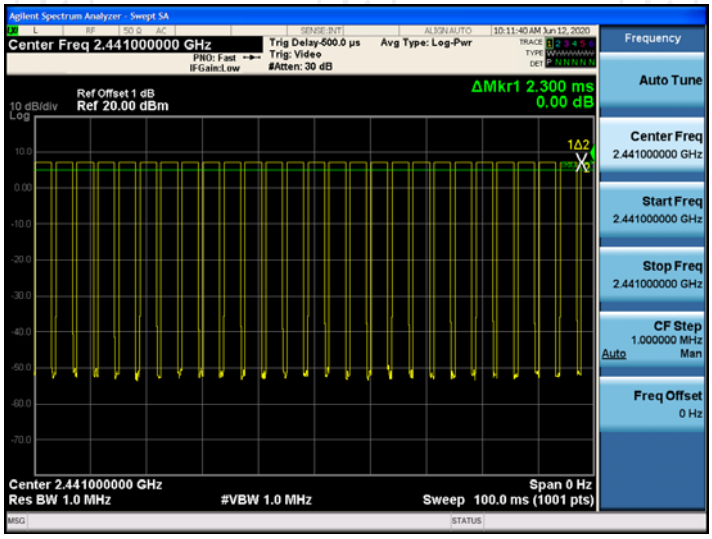
6.11.3. Test Data

Duty cycle correction factor for average measurement

DH5 on time (One Pulse) Plot on Channel 39



DH5 on time (Count Pulses) Plot on Channel 39



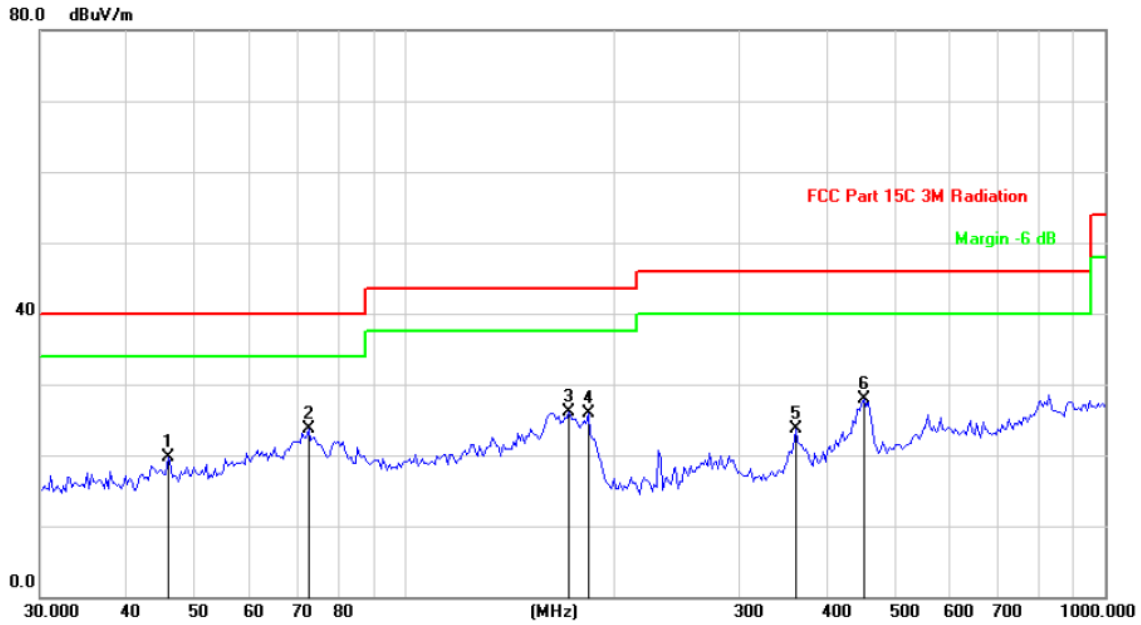
Note:

1. *Worst case Duty cycle = on time/100 milliseconds = (2.885*26+2.300)/100= 0.7731*
2. *Worst case Duty cycle correction factor = 20*log (Duty cycle) = -2.24dB*
3. *DH5 has the highest duty cycle worst case and is reported.*
4. *The average levels were calculated from the peak level corrected with duty cycle correction factor (-2.24dB) derived from 20log (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.*

Please refer to following diagram for individual

Below 1GHz

Horizontal:



Site	Polarization: *Horizontal*	Temperature:	25
Limit: FCC Part 15C 3M Radiation	Power: AC 120V/60Hz	Humidity:	55 %

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dB/m	dB	Detector
1		45.7333	30.35	-10.58	19.77	40.00	-20.23	peak
2	*	72.7203	39.93	-16.20	23.73	40.00	-16.27	peak
3		171.3890	41.65	-15.61	26.04	43.50	-17.46	peak
4		182.5785	40.90	-15.09	25.81	43.50	-17.69	peak
5		360.9775	33.31	-9.55	23.76	46.00	-22.24	peak
6		452.0013	36.09	-8.15	27.94	46.00	-18.06	peak

Vertical:

Site	Polarization: *Vertical*	Temperature:	25
Limit: FCC Part 15C 3M Radiation	Power: AC 120V/60Hz	Humidity:	55 %

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dB/m	dB	Detector
1	*	31.5125	39.77	-11.15	28.62	40.00	-11.38	peak
2		52.6345	38.58	-10.77	27.81	40.00	-12.19	peak
3		72.7202	42.76	-16.20	26.56	40.00	-13.44	peak
4		113.2200	36.13	-10.16	25.97	43.50	-17.53	peak
5		164.3129	45.99	-15.94	30.05	43.50	-13.45	peak
6		458.3987	33.72	-8.03	25.69	46.00	-20.31	peak

Note: *1.The low frequency, which started from 9KHz~30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.*

2. Measurements were conducted in all three channels (high, middle, low) and three modulation (GFSK, Pi/4 DQPSK, 8DPSK) and the worst case Mode (Highest channel and GFSK) was submitted only.

3. Freq. = Emission frequency in MHz

Measurement (dBµV/m) = Reading level (dBµV) + Corr. Factor (dB)

Correction Factor= Antenna Factor + Cable loss – Pre-amplifier

Limit (dBµV/m) = Limit stated in standard

Over (dB) = Measurement (dBµV/m) – Limits (dBµV/m)

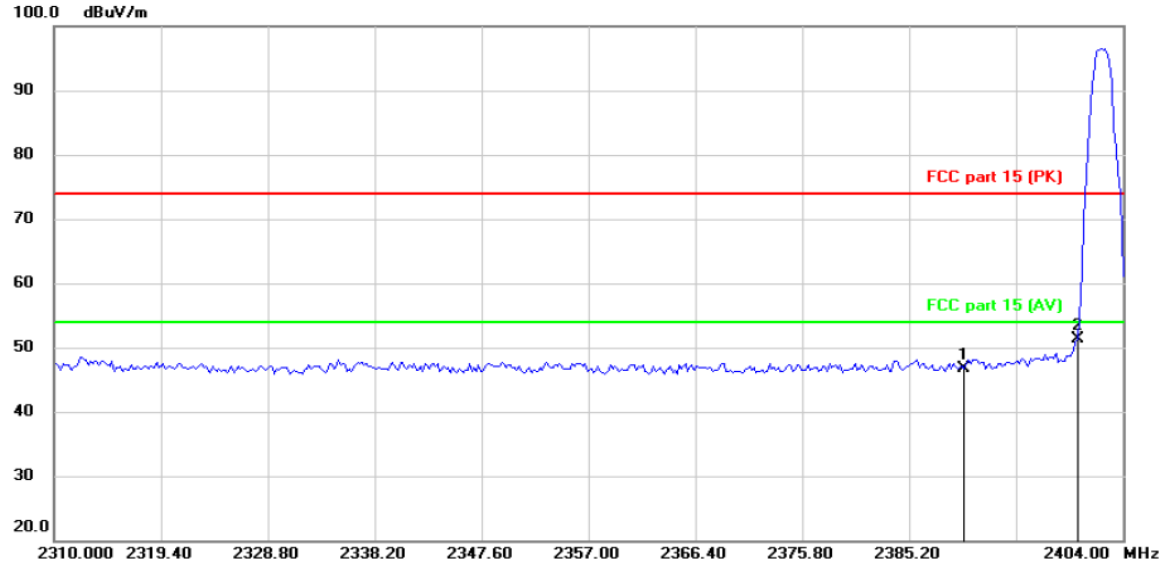
Any value more than 10dB below limit have not been specifically reported

** is meaning the worst frequency has been tested in the test frequency range.*

Test Result of Radiated Spurious at Band edges

Lowest channel 2402:

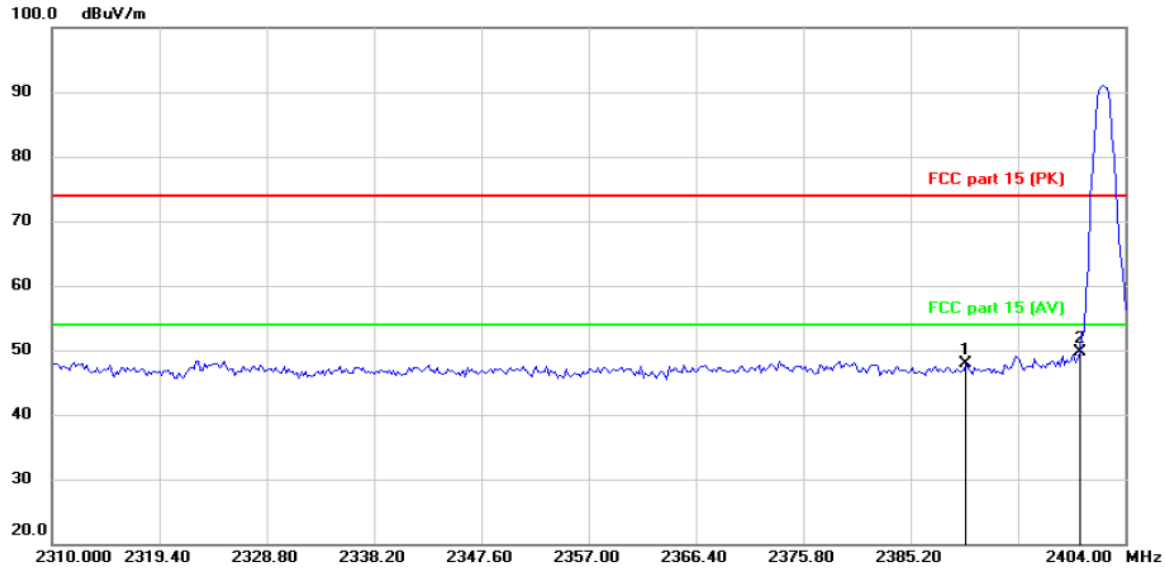
Horizontal:



Site | Polarization: *Horizontal* | Temperature: 25

Limit: FCC part 15 (PK) | Power: | Humidity: 55 %

Vertical:



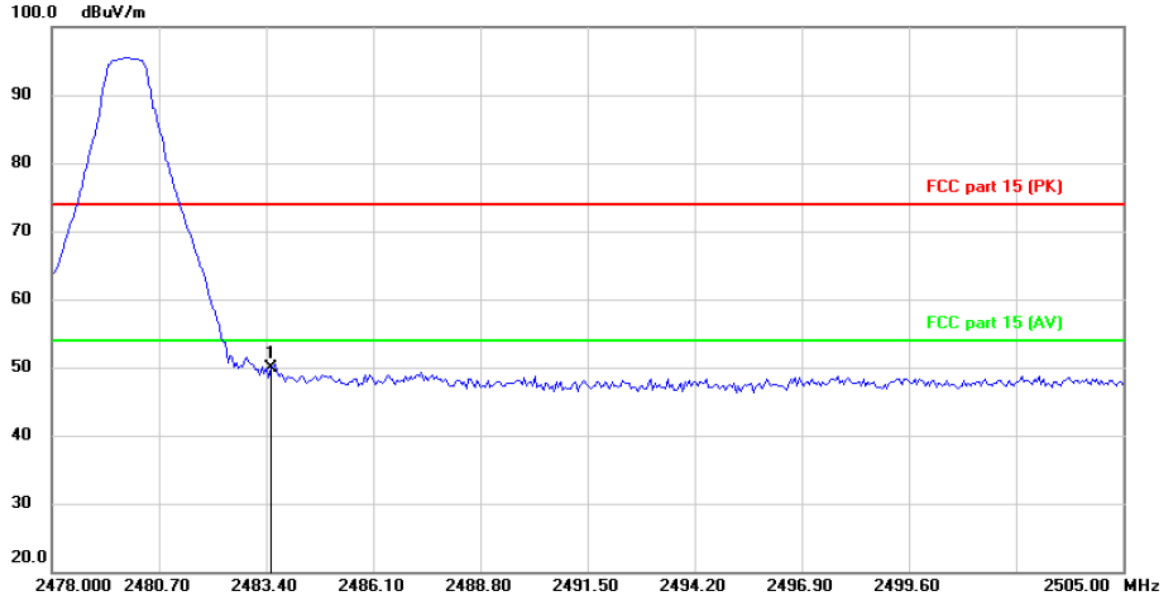
Site Demo | Polarization: *Vertical* | Temperature: 25

Limit: FCC part 15 (PK) | Power: | Humidity: 55 %

Frequency (MHz)	Ant. Pol. H/V	Peak (dBμV/m)	Duty cycle factor (dB/m)	AV (dBμV/m)	Peak limit (dBμV/m)	AV limit (dBμV/m)	PK Margin (dB)	AVG Margin (dB)
2390	H	46.77	-2.24	44.53	74	54	-27.23	-9.47
2390	V	47.89	-2.24	45.65	74	54	-26.11	-8.35
2400	H	51.30	-2.24	49.06	74	54	-22.70	-4.94
2400	V	49.69	-2.24	47.45	74	54	-24.31	-6.55

Highest channel 2480:

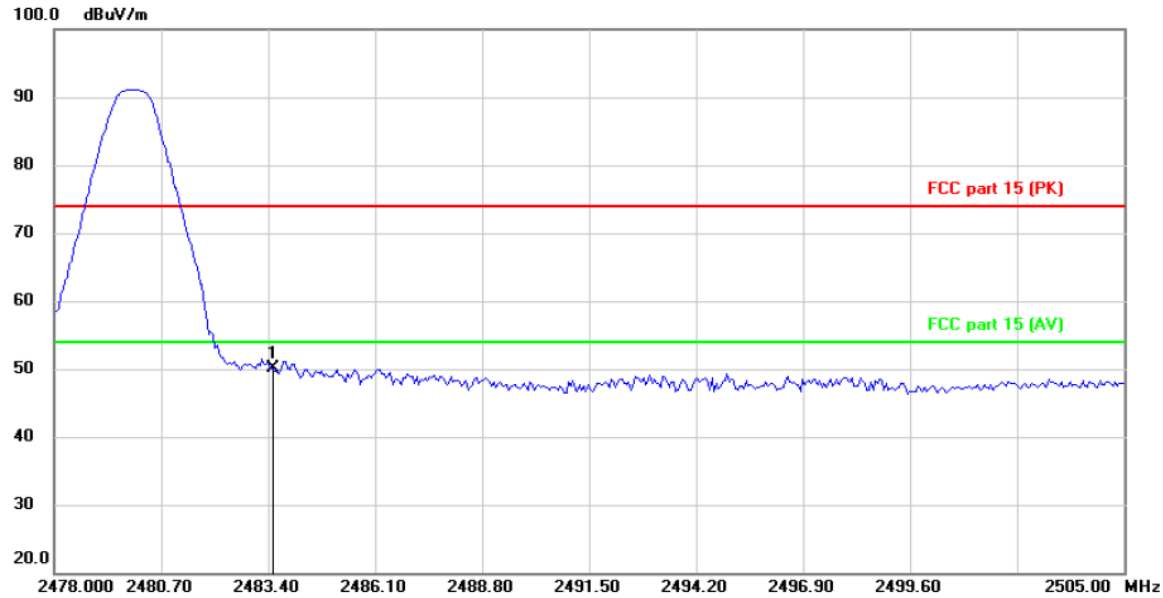
Horizontal:



Site | Polarization: *Horizontal* | Temperature: 25

Limit: FCC part 15 (PK) | Power: | Humidity: 55 %

Vertical:



Site | Polarization: *Vertical* | Temperature: 25

Limit: FCC part 15 (PK) | Power: | Humidity: 55 %

Frequency (MHz)	Ant. Pol. H/V	Peak (dBμV/m)	Duty cycle factor (dB/m)	AV (dBμV/m)	Peak limit (dBμV/m)	AV limit (dBμV/m)	PK Margin (dB)	AVG Margin (dB)
2483.5	H	49.85	-2.24	47.61	74	54	-24.15	-6.39
2483.5	V	50.19	-2.24	47.95	74	54	-23.81	-6.05

Note: *Measurements were conducted in all three modulation (GFSK, Pi/4 DQPSK, 8DPSK), and the worst case Mode (GFSK) was submitted only.*

Above 1GHz

Modulation Type: GFSK									
Low channel: 2402 MHz									
Frequency (MHz)	Ant. Pol. H/V	Peak reading (dBμV)	AV reading (dBuV)	Correction Factor (dB/m)	Emission Level Peak (dBμV/m)	Emission Level AV (dBμV/m)	Peak limit (dBμV/m)	AV limit (dBμV/m)	Margin (dB)
4804	H	45.68	---	0.66	46.34	---	74	54	-7.66
7206	H	36.24	---	9.50	45.74	---	74	54	-8.26
---	H	---	---	---	---	---	---	---	---
4804	V	46.15	---	0.66	46.81	---	74	54	-7.19
7206	V	37.02	---	9.50	46.52	---	74	54	-7.48
---	V	---	---	---	---	---	---	---	---

Middle channel: 2441 MHz									
Frequency (MHz)	Ant. Pol. H/V	Peak reading (dBμV)	AV reading (dBμV)	Correction Factor (dB/m)	Emission Level Peak (dBμV/m)	Emission Level AV (dBμV/m)	Peak limit (dBμV/m)	AV limit (dBμV/m)	Margin (dB)
4882	H	45.92	---	0.99	46.91	---	74	54	-7.09
7323	H	36.34	---	9.87	46.21	---	74	54	-7.79
---	H	---	---	---	---	---	---	---	---
4882	V	44.89	---	0.99	45.88	---	74	54	-8.12
7323	V	35.42	---	9.87	45.29	---	74	54	-8.71
---	V	---	---	---	---	----	---	---	---

High channel: 2480 MHz									
Frequency (MHz)	Ant. Pol. H/V	Peak reading (dBμV)	AV reading (dBμV)	Correction Factor (dB/m)	Emission Level Peak (dBμV/m)	Emission Level AV (dBμV/m)	Peak limit (dBμV/m)	AV limit (dBμV/m)	Margin (dB)
4960	H	46.61	---	1.33	47.94	---	74	54	-6.06
7440	H	37.52	---	10.22	47.74	---	74	54	-6.26
---	H	---	---	---	---	---	---	---	---
4960	V	47.75	---	1.33	49.08	---	74	54	-4.92
7440	V	38.01	---	10.22	48.23	---	74	54	-5.77
---	V	---	---	---	---	---	---	---	---

Note:

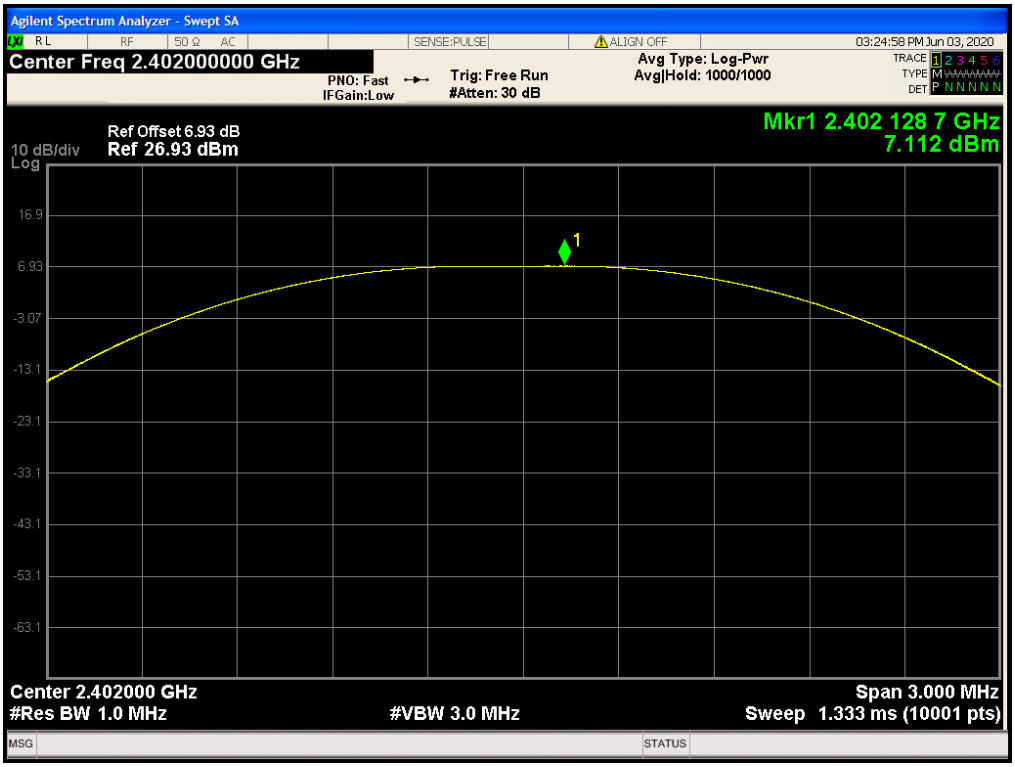
1. *Emission Level=Peak Reading + Correction Factor; Correction Factor= Antenna Factor + Cable loss – Pre-amplifier*
2. *Margin (dB) = Emission Level (Peak) (dBμV/m)-Average limit (dBμV/m)*
3. *The emission levels of other frequencies are very lower than the limit and not show in test report.*
4. *Measurements were conducted from 1 GHz to the 10th harmonic of highest fundamental frequency.*
5. *Data of measurement shown "---"in the above table mean that the reading of emissions is attenuated more than 20 dB below the limits or the field strength is too small to be measured.*
6. *Measurements were conducted in all three modulation (GFSK, Pi/4 DQPSK, 8DPSK), and the worst case Mode (GFSK) was submitted only.*
7. *All the restriction bands are compliance with the limit of 15.209.*

Appendix A: Test Result of Conducted Test

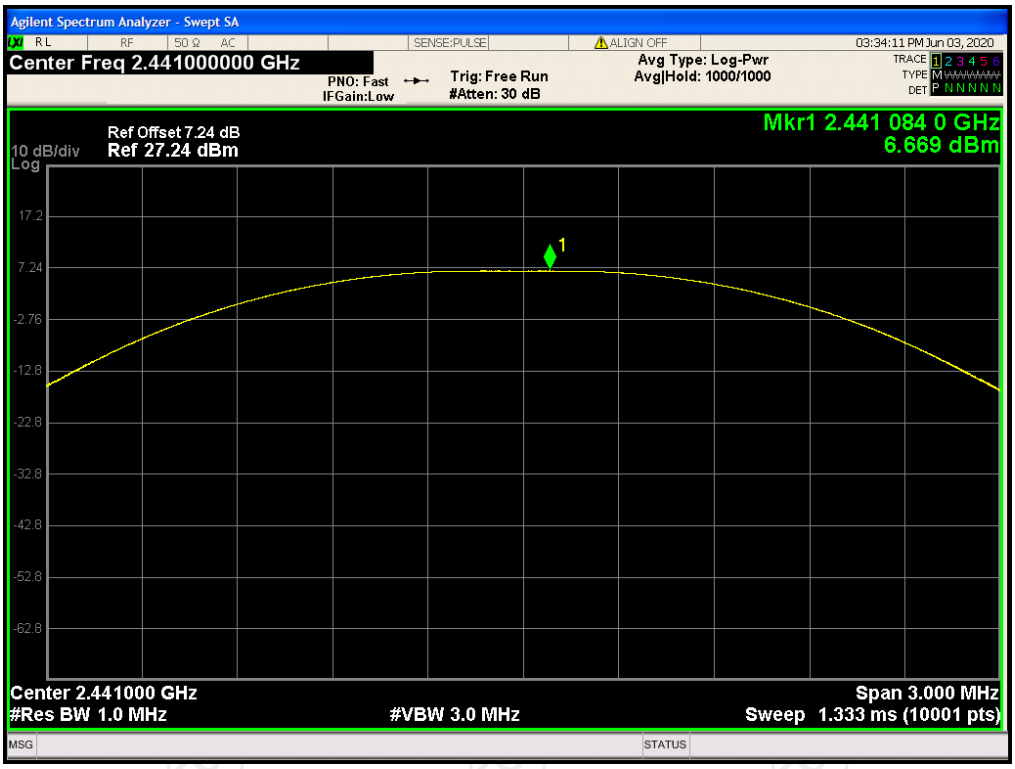
Maximum Conducted Output Power

Mode	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Verdict
1-DH1	2402	7.112	30	Pass
1-DH1	2441	6.669	30	Pass
1-DH1	2480	8.400	30	Pass
2-DH1	2402	6.441	21	Pass
2-DH1	2441	5.676	21	Pass
2-DH1	2480	7.490	21	Pass
3-DH1	2402	6.835	21	Pass
3-DH1	2441	6.156	21	Pass
3-DH1	2480	8.000	21	Pass

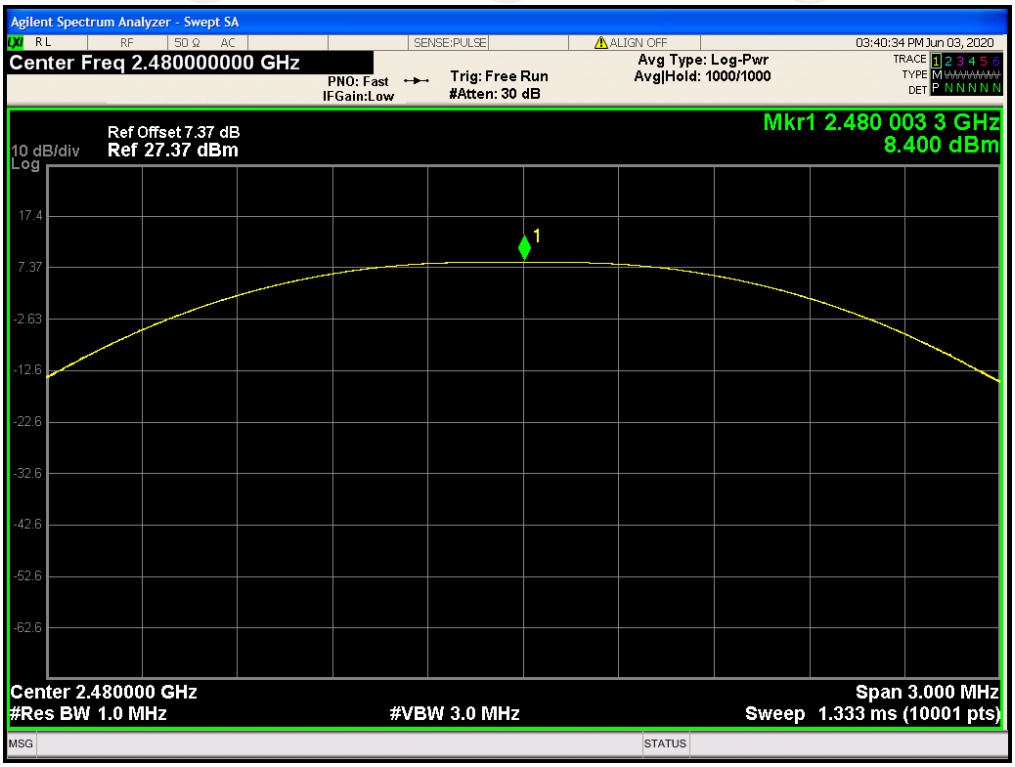
Power NVNT 1-DH1 2402MHz



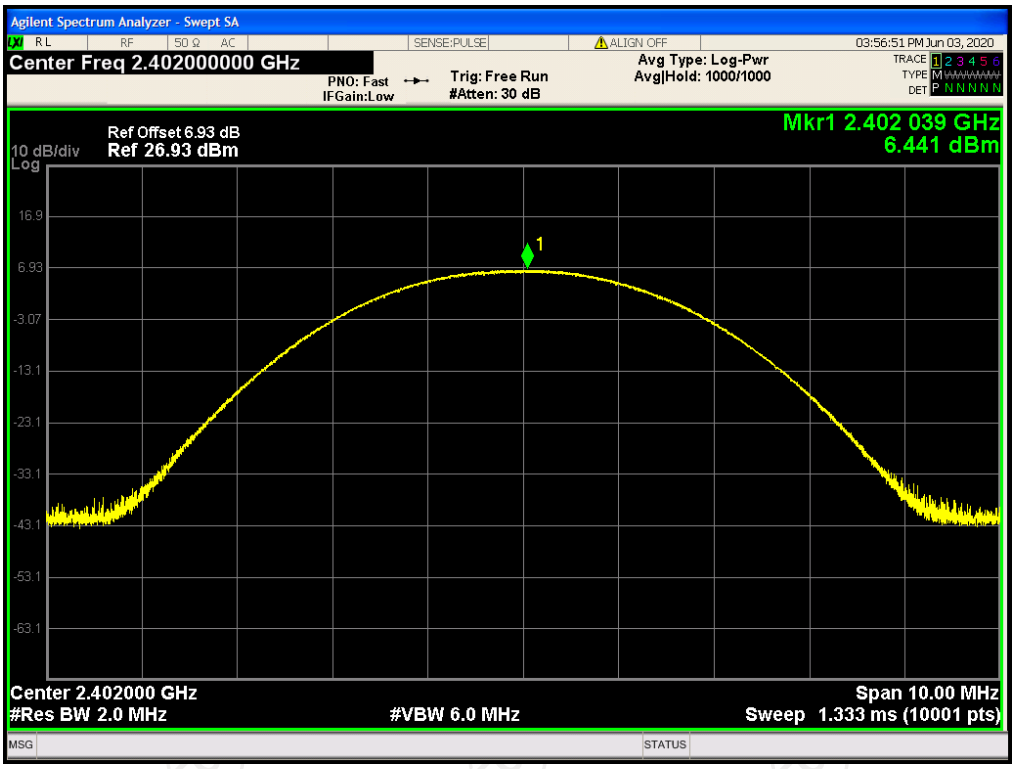
Power NVNT 1-DH1 2441MHz



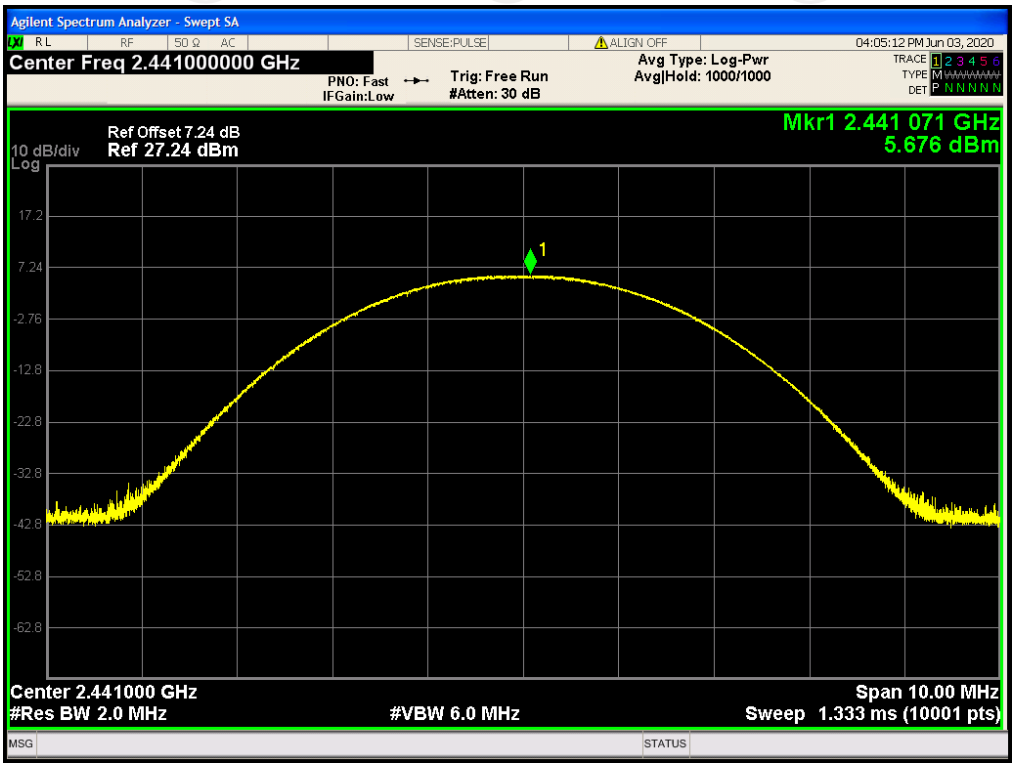
Power NVNT 1-DH1 2480MHz



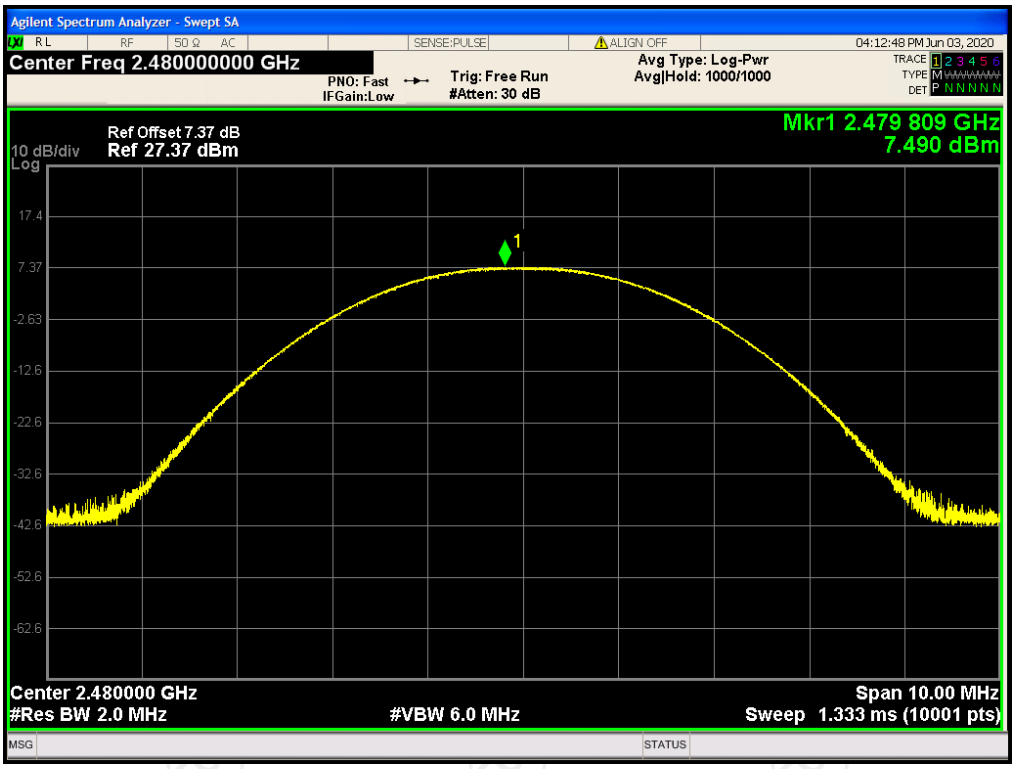
Power NVNT 2-DH1 2402MHz



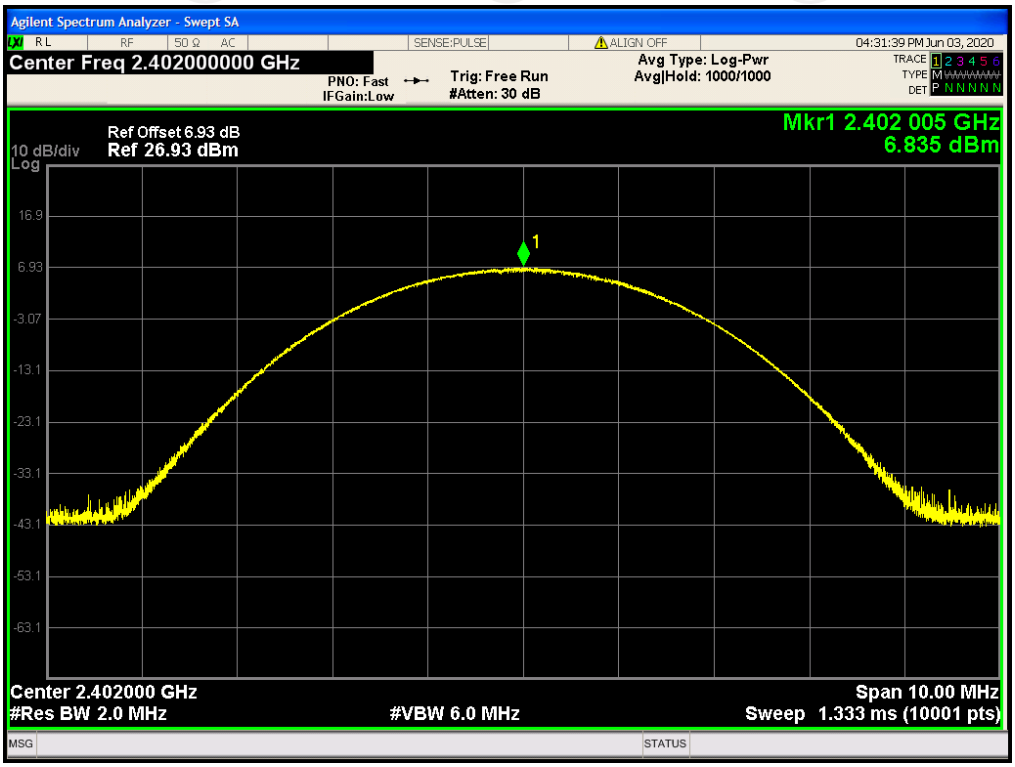
Power NVNT 2-DH1 2441MHz



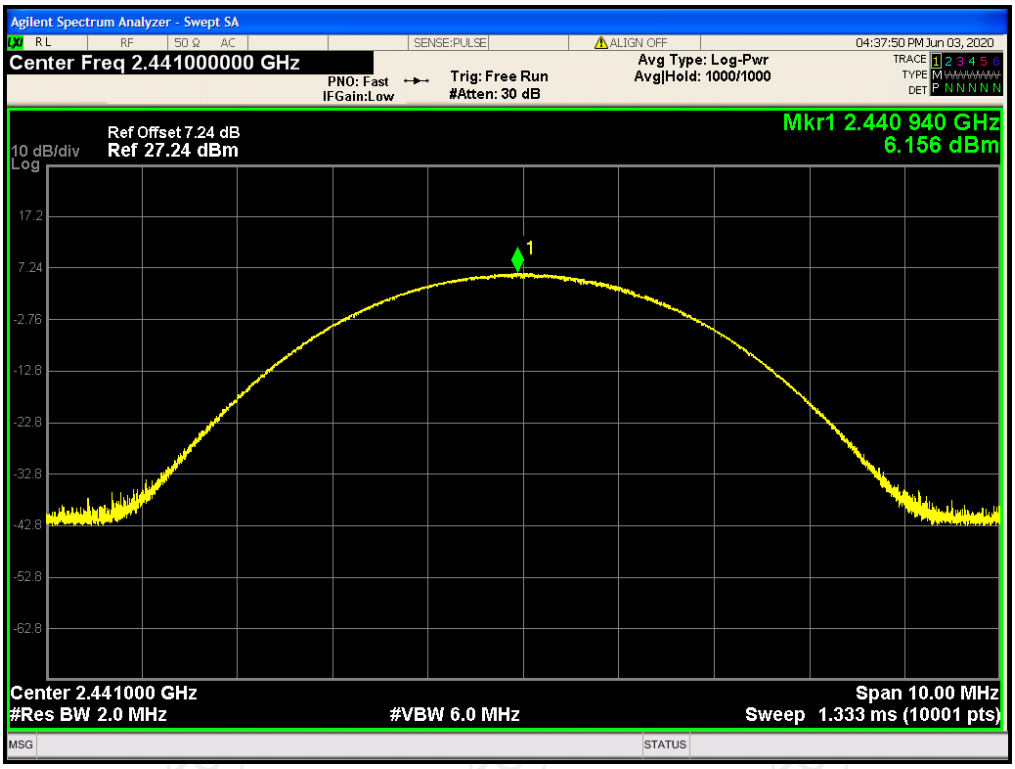
Power NVNT 2-DH1 2480MHz



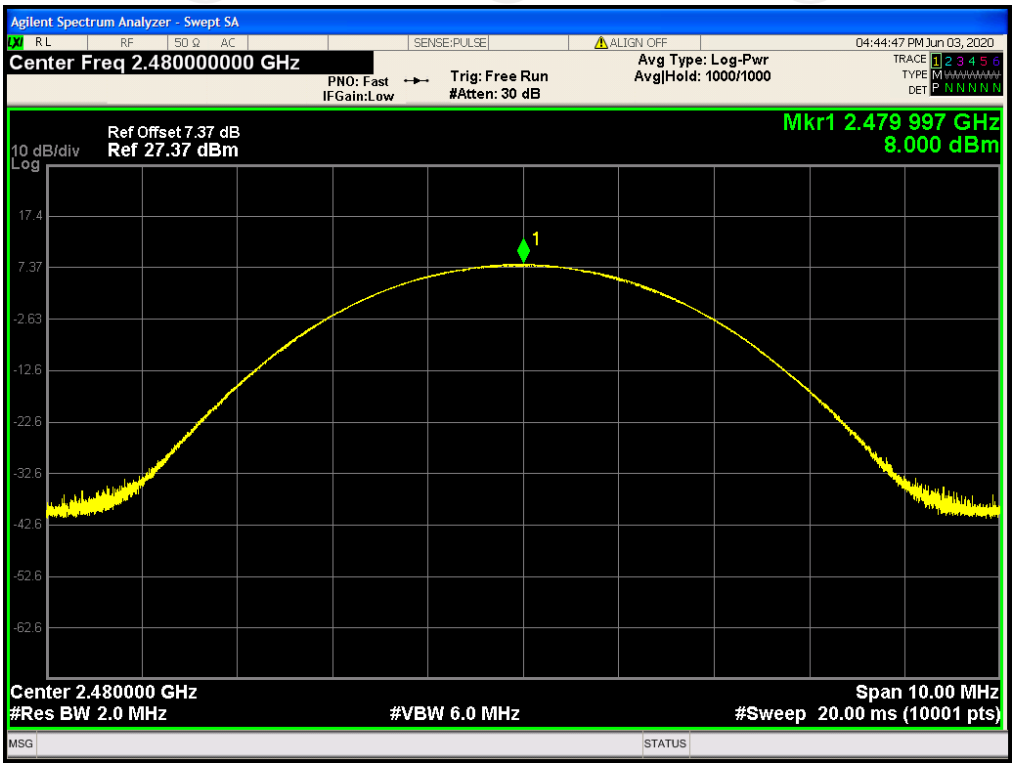
Power NVNT 3-DH1 2402MHz



Power NVNT 3-DH1 2441MHz



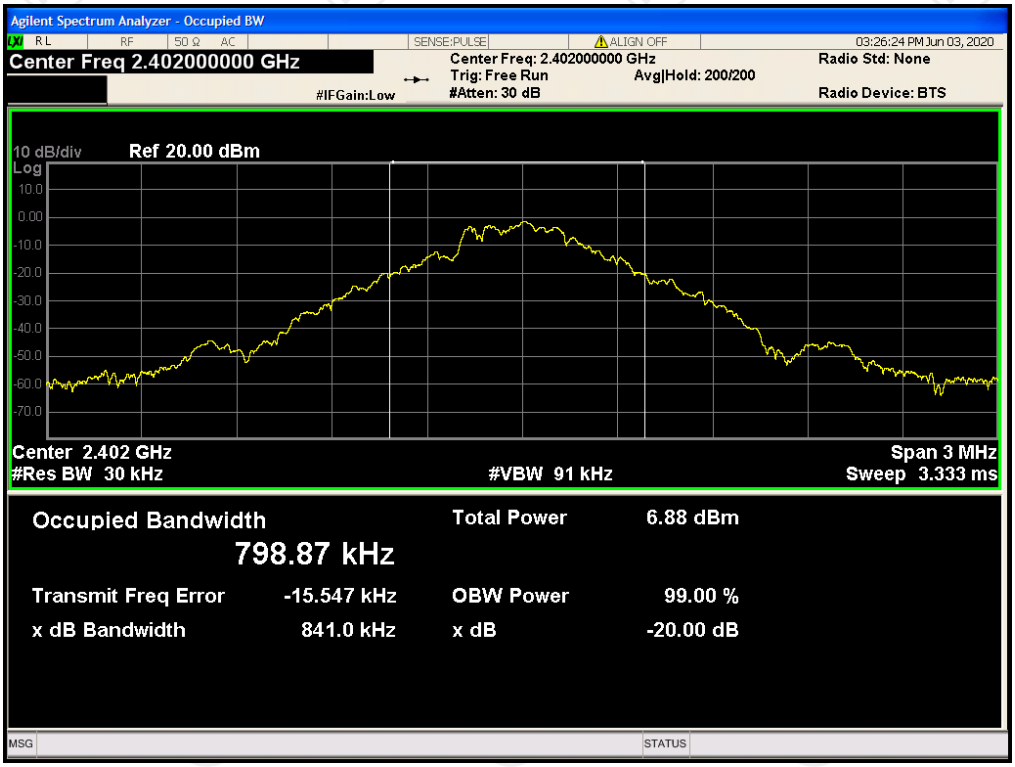
Power NVNT 3-DH1 2480MHz



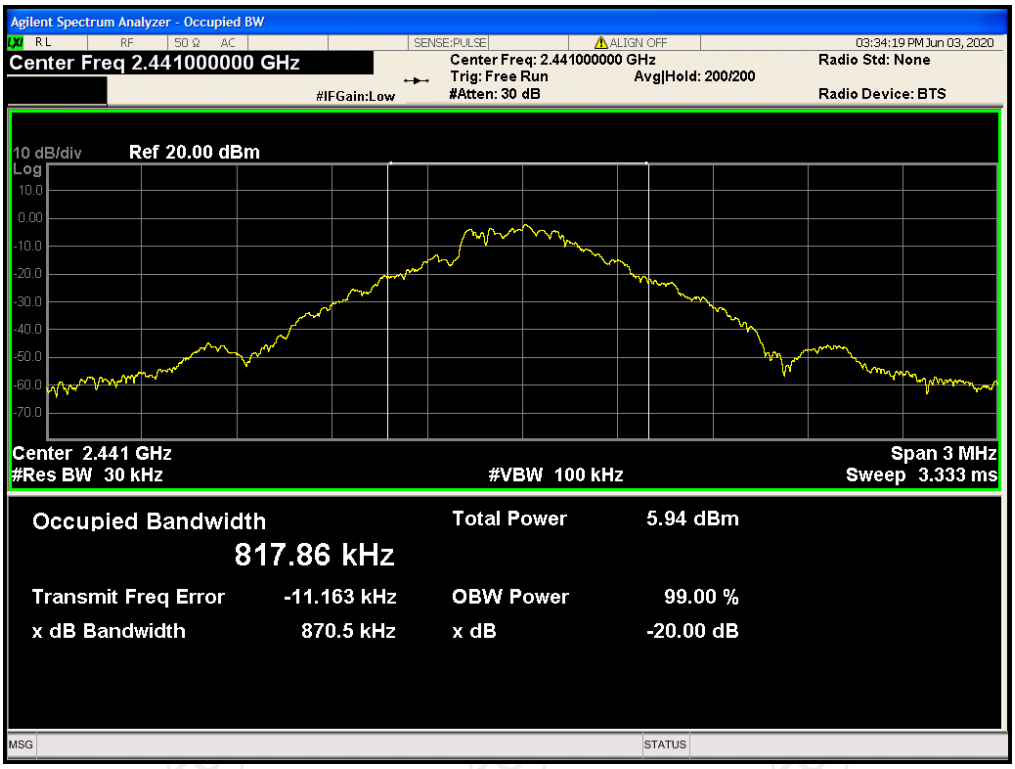
Occupied Channel Bandwidth

Mode	Frequency (MHz)	-20 dB Bandwidth (MHz)	Verdict
1-DH1	2402	0.8410	Pass
1-DH1	2441	0.8705	Pass
1-DH1	2480	0.8690	Pass
2-DH1	2402	1.2587	Pass
2-DH1	2441	1.2573	Pass
2-DH1	2480	1.2545	Pass
3-DH1	2402	1.2133	Pass
3-DH1	2441	1.2215	Pass
3-DH1	2480	1.2192	Pass

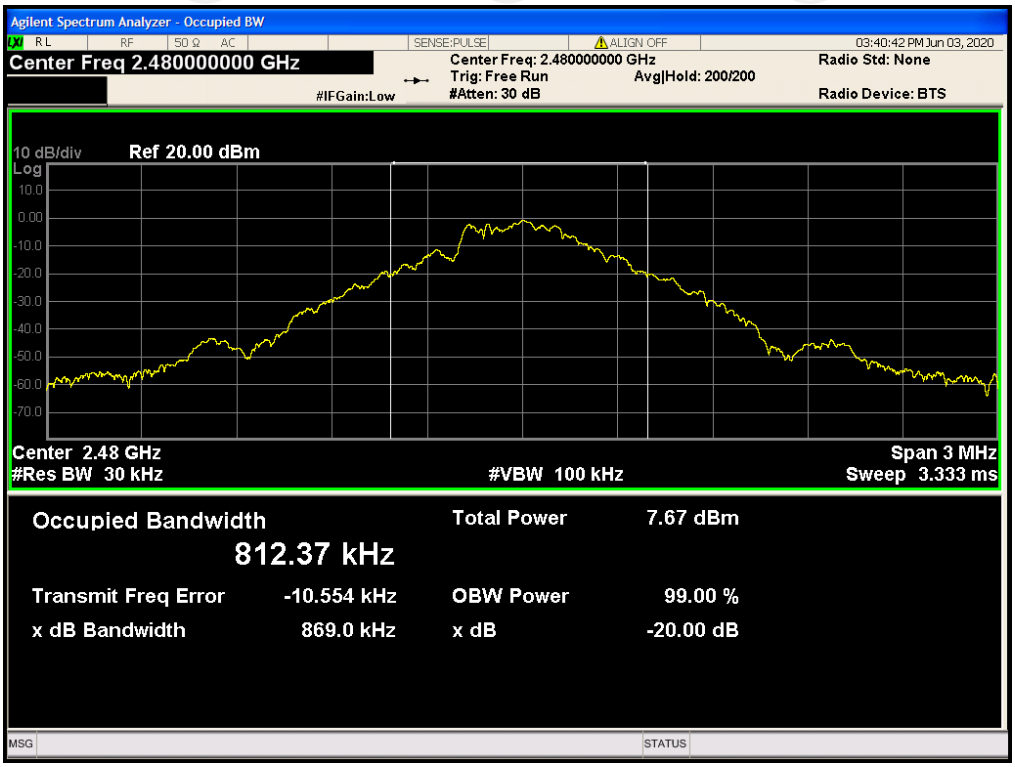
OBW NVNT 1-DH1 2402MHz



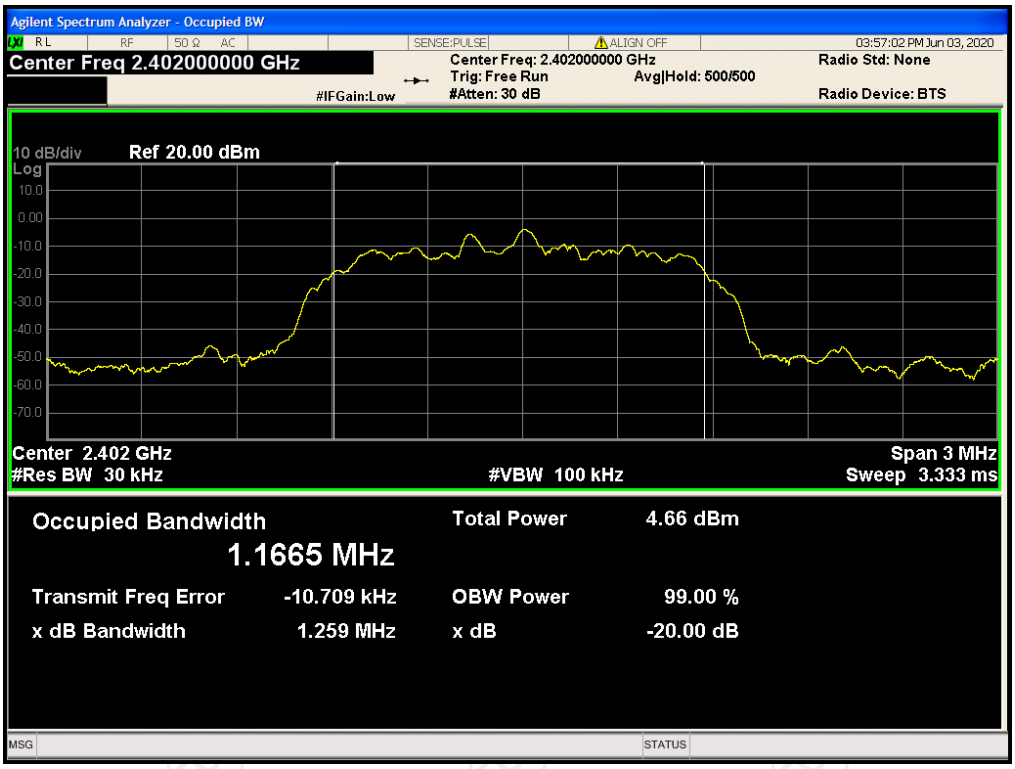
OBW NVNT 1-DH1 2441MHz



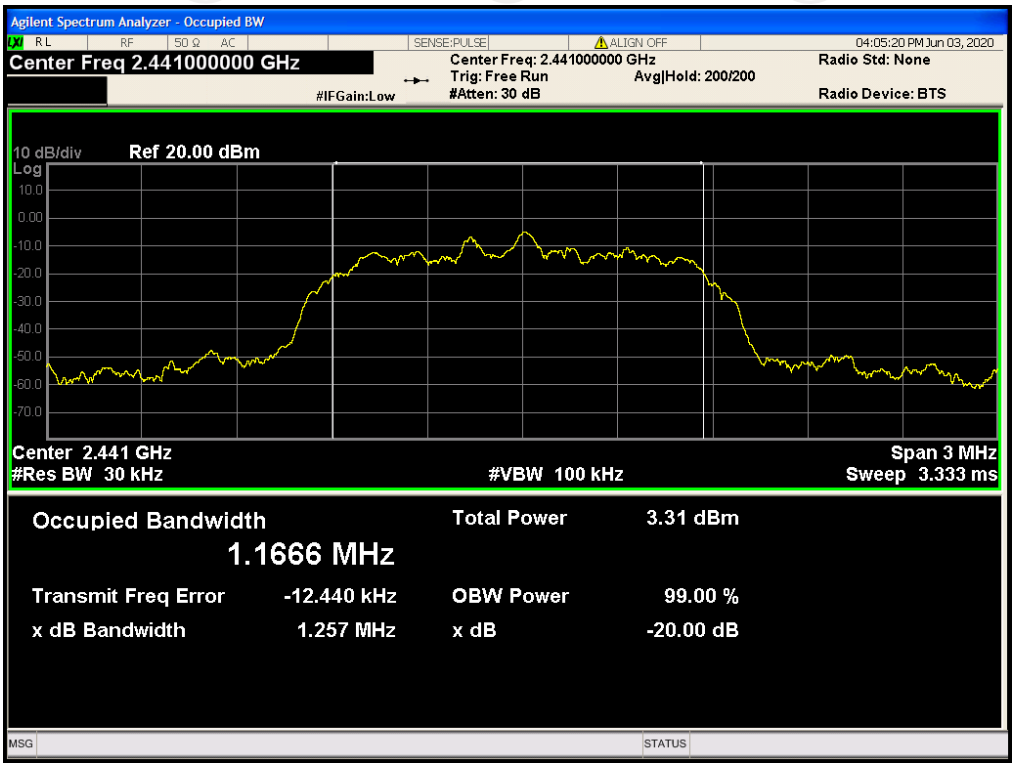
OBW NVNT 1-DH1 2480MHz



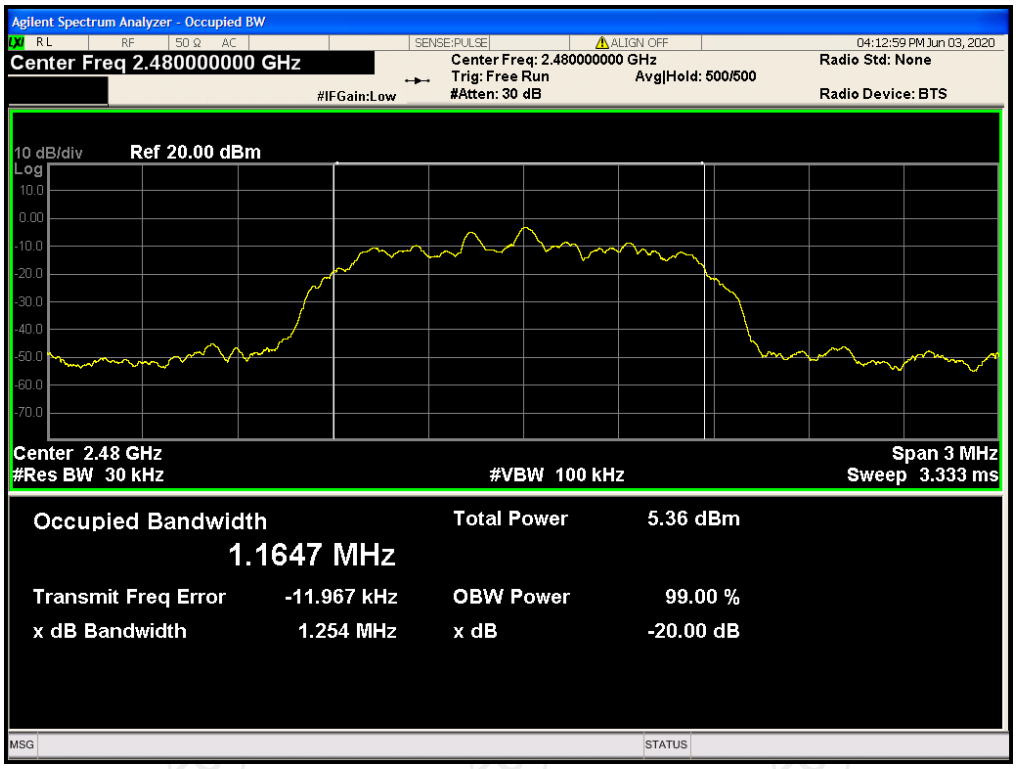
OBW NVNT 2-DH1 2402MHz



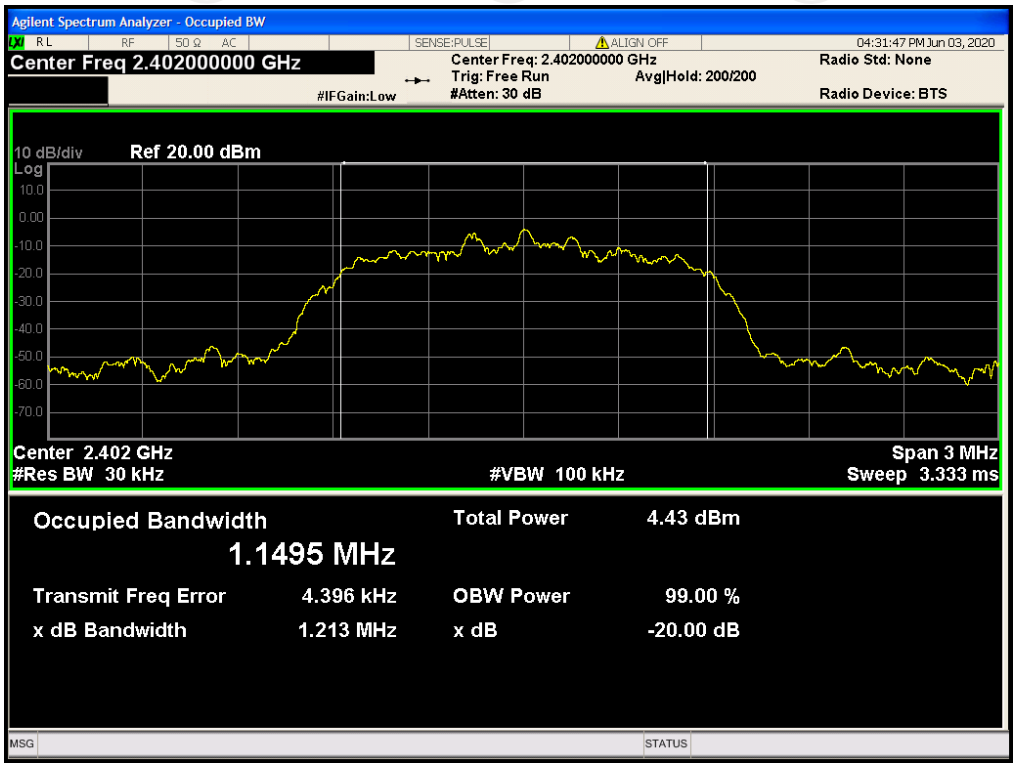
OBW NVNT 2-DH1 2441MHz



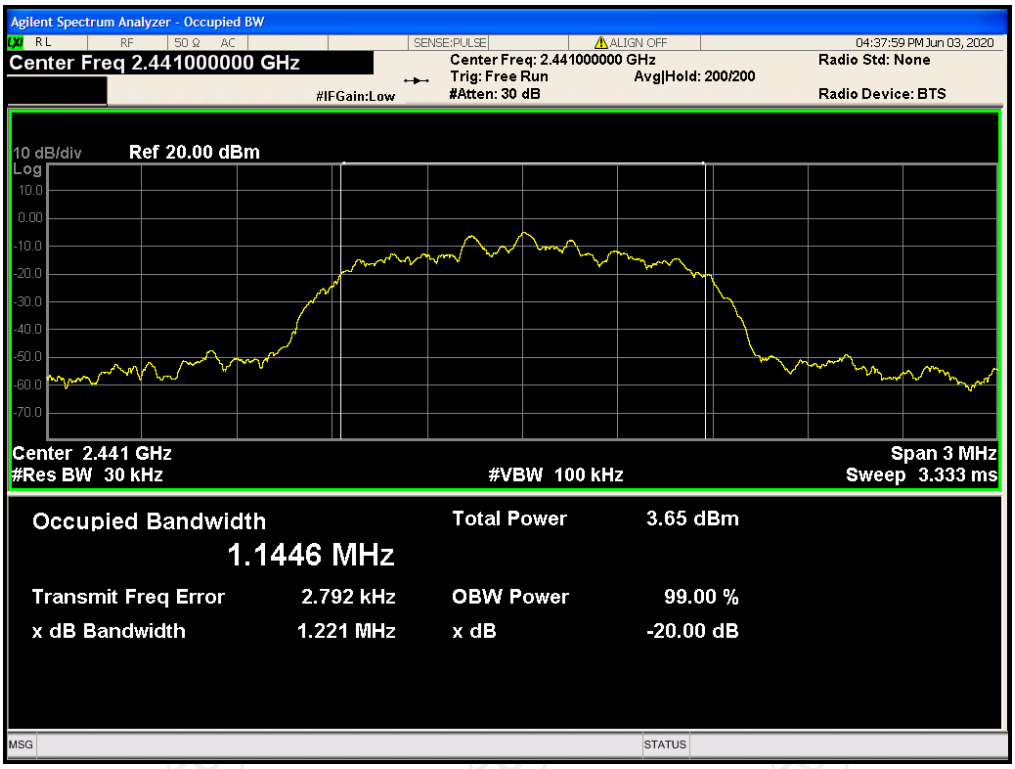
OBW NVNT 2-DH1 2480MHz



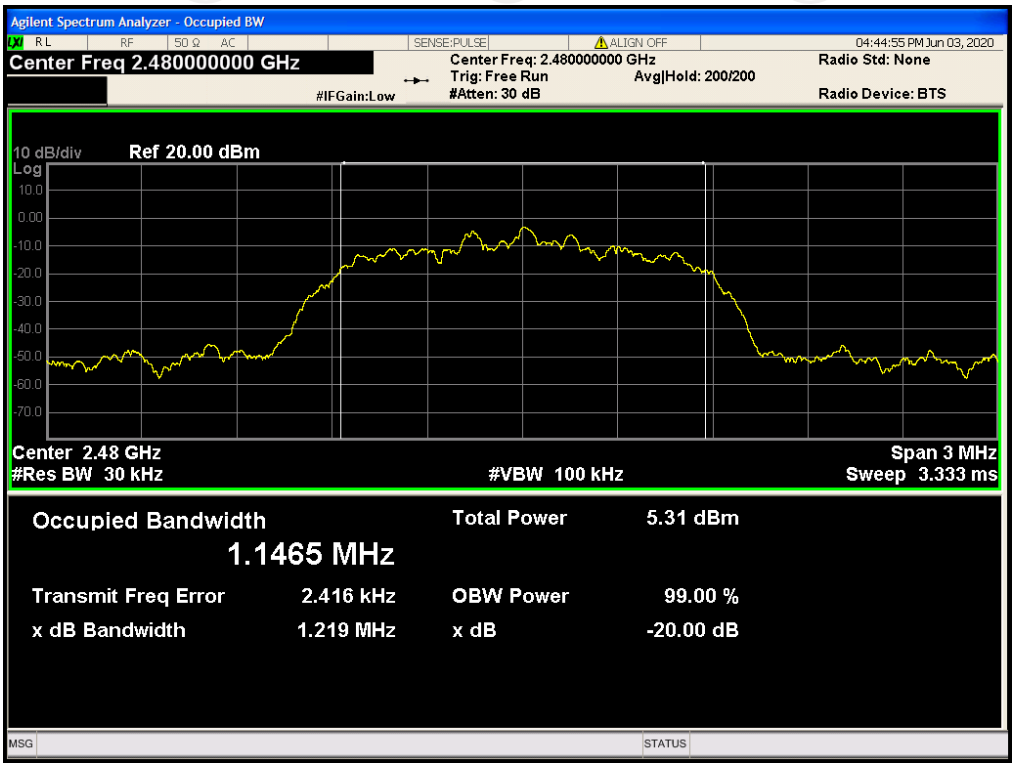
OBW NVNT 3-DH1 2402MHz



OBW NVNT 3-DH1 2441MHz



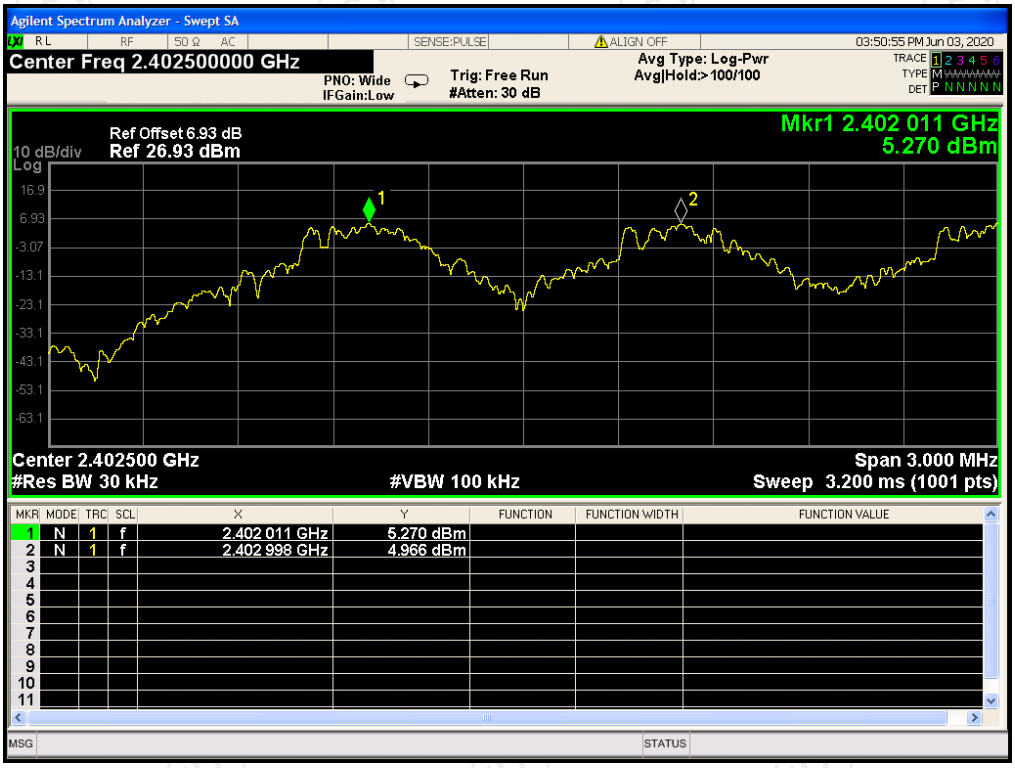
OBW NVNT 3-DH1 2480MHz



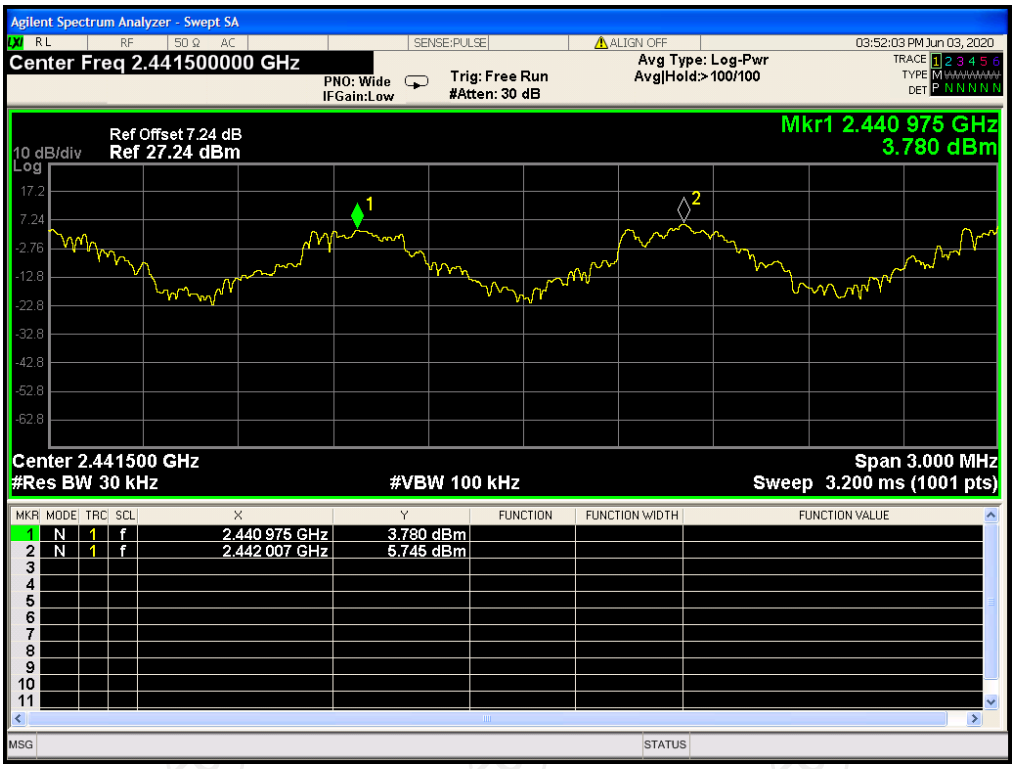
Carrier Frequencies Separation

Mode	Hopping Freq1 (MHz)	Hopping Freq2 (MHz)	HFS (MHz)	Limit (MHz)	Verdict
1-DH1	2402.011	2402.998	0.987	0.869	Pass
1-DH1	2440.975	2442.007	1.032	0.869	Pass
1-DH1	2479.002	2480.001	0.999	0.869	Pass
2-DH1	2402.008	2403.022	1.014	0.836	Pass
2-DH1	2441.014	2442.013	0.999	0.836	Pass
2-DH1	2479.008	2480.004	0.996	0.836	Pass
3-DH1	2402.002	2403.007	1.005	0.813	Pass
3-DH1	2441.017	2442.007	0.990	0.813	Pass
3-DH1	2479.002	2480.007	1.005	0.813	Pass

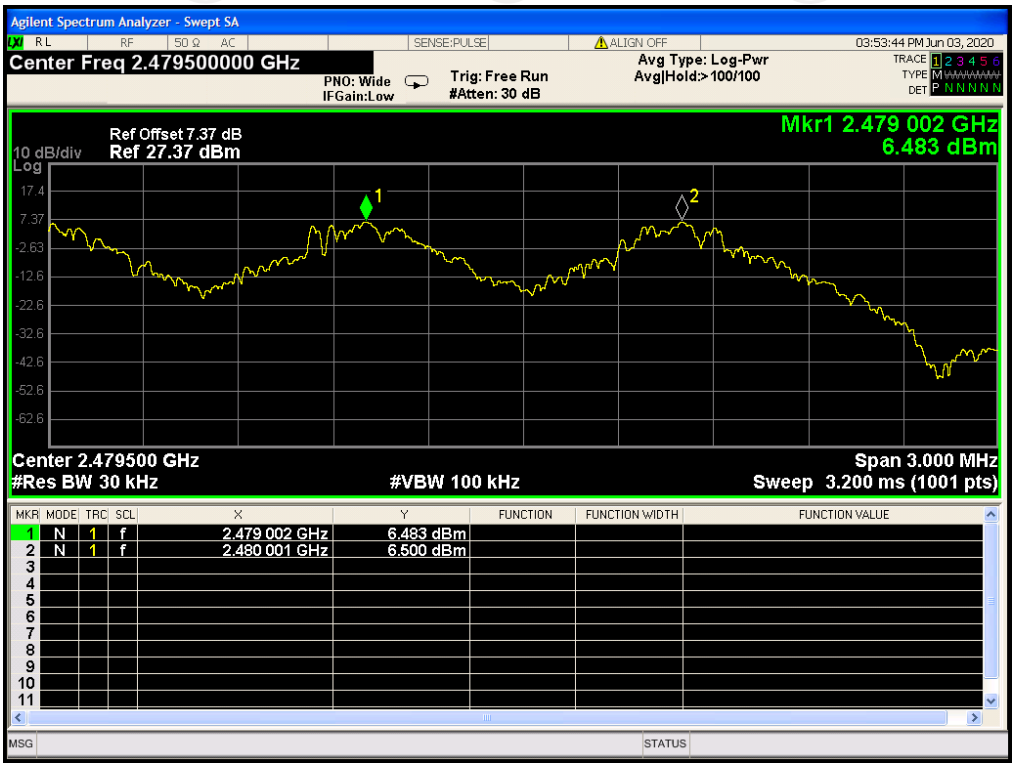
CFS NVNT 1-DH1 2402MHz



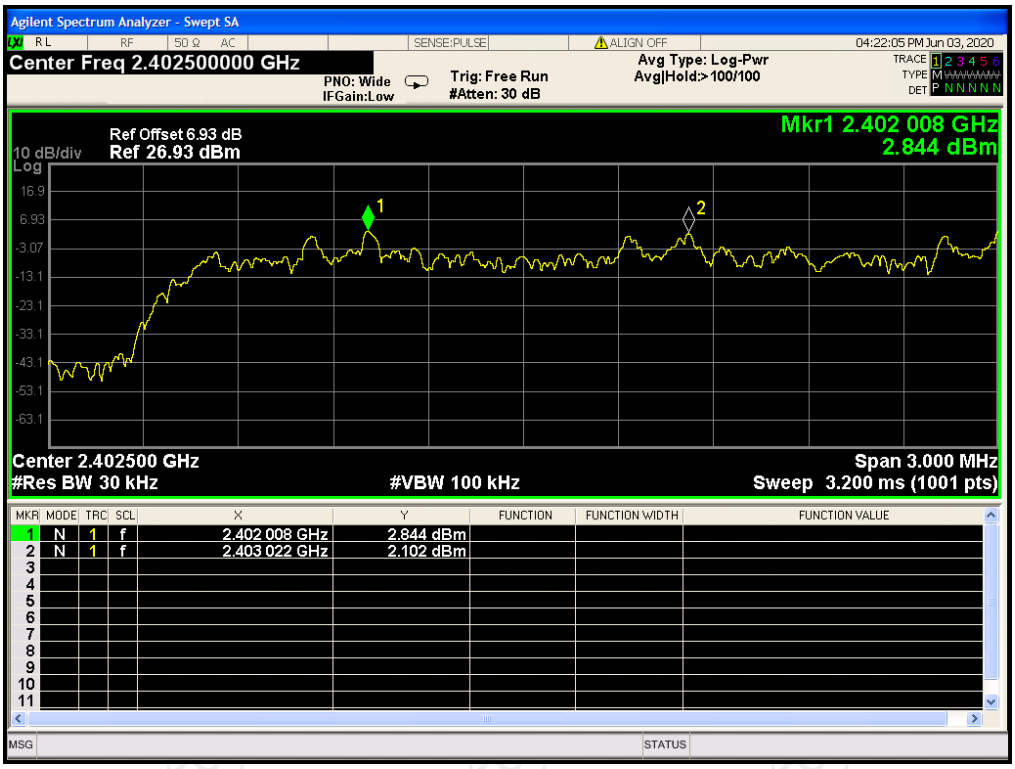
CFS NVNT 1-DH1 2441MHz



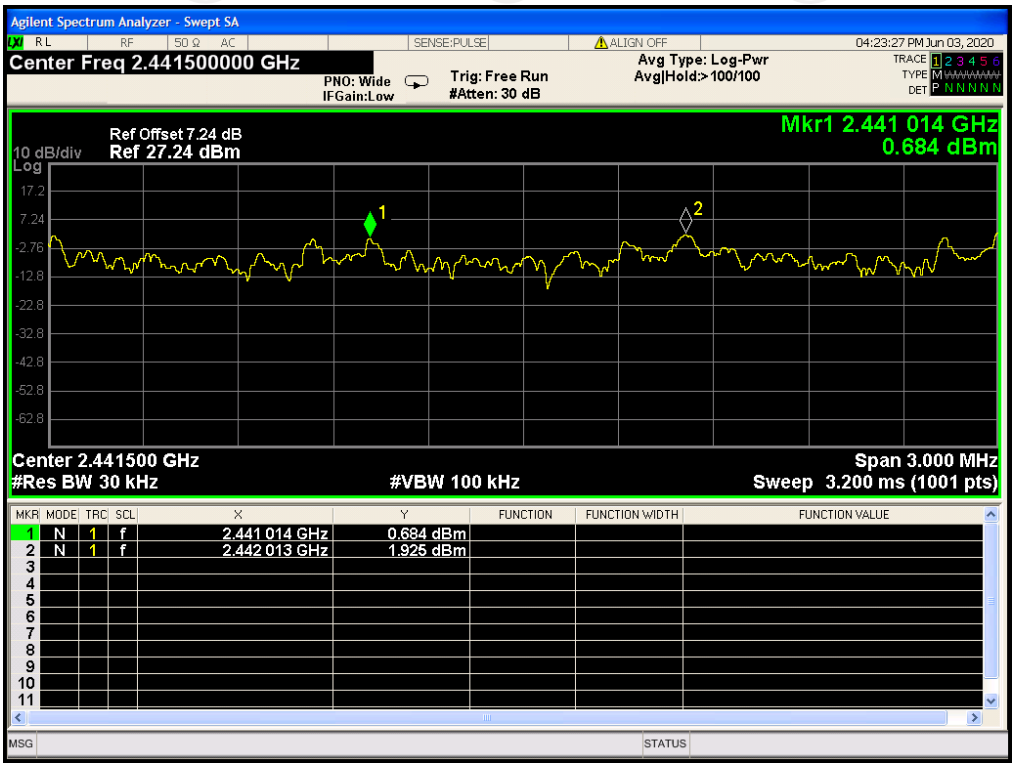
CFS NVNT 1-DH1 2480MHz



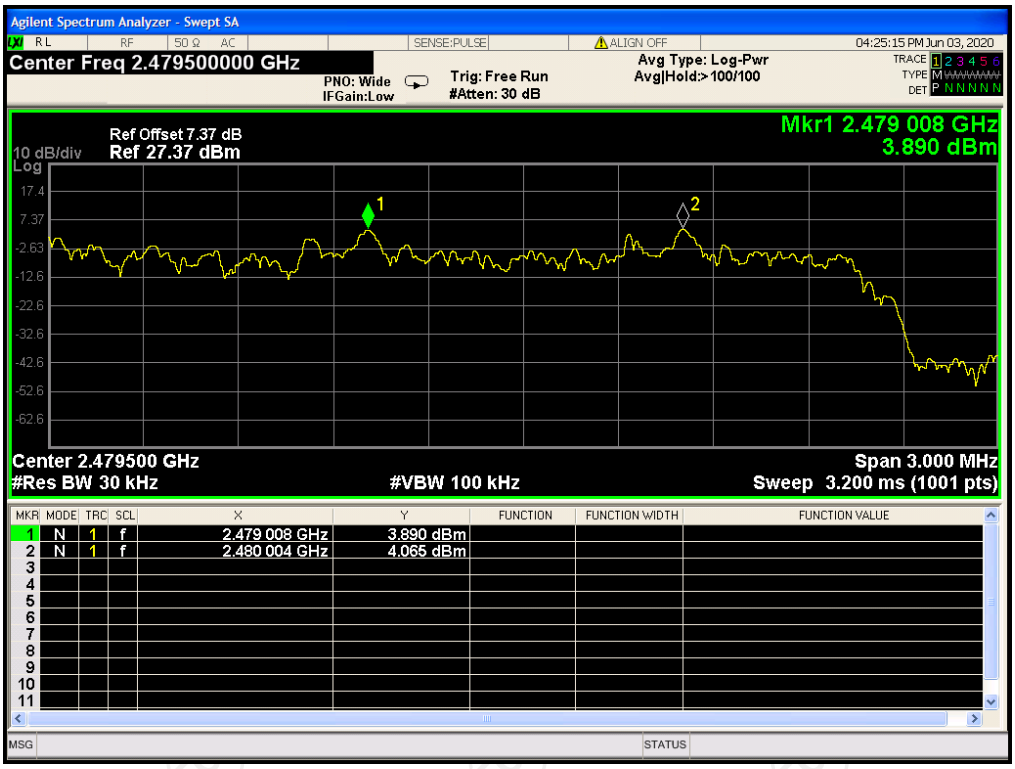
CFS NVNT 2-DH1 2402MHz



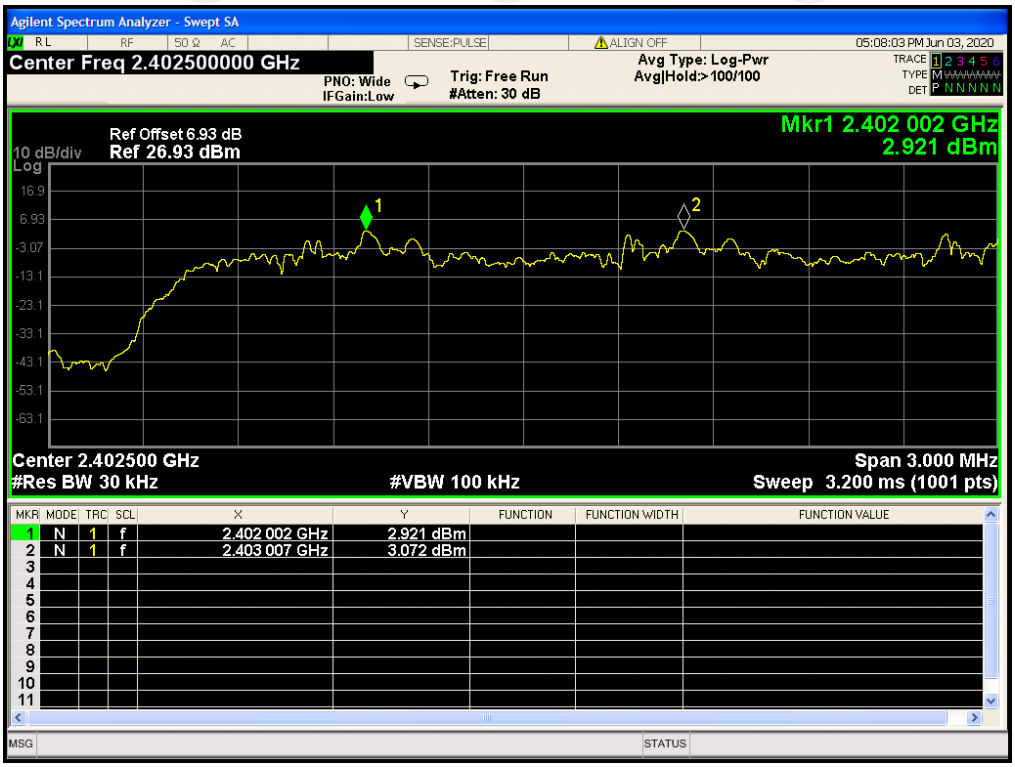
CFS NVNT 2-DH1 2441MHz



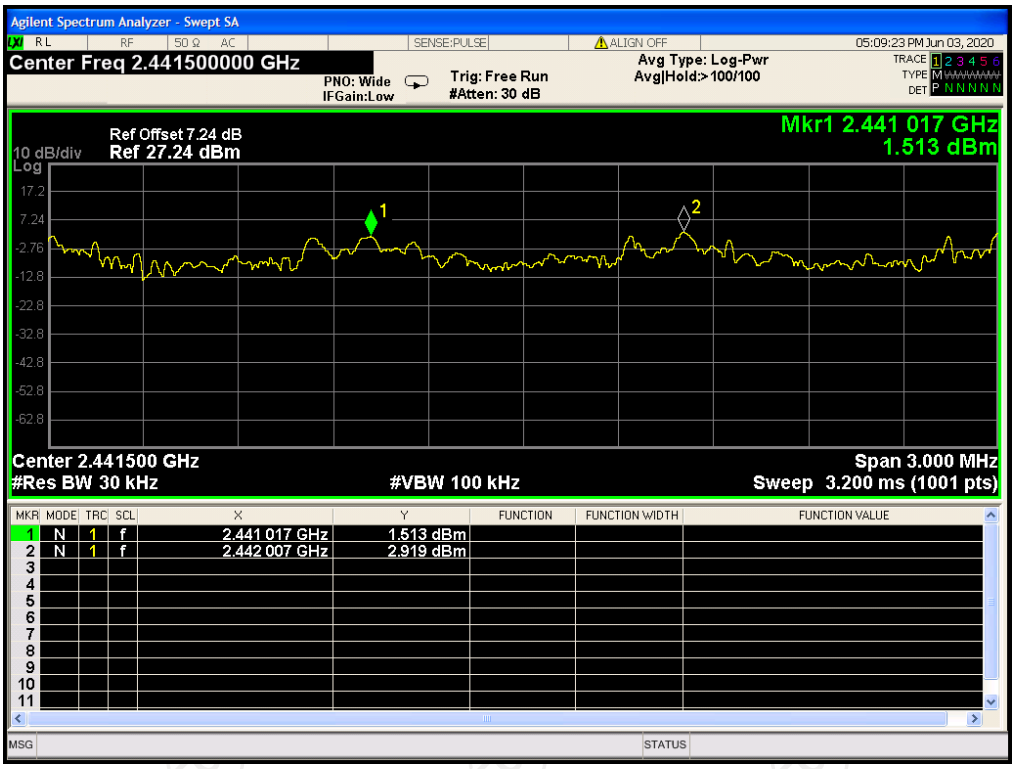
CFS NVNT 2-DH1 2480MHz



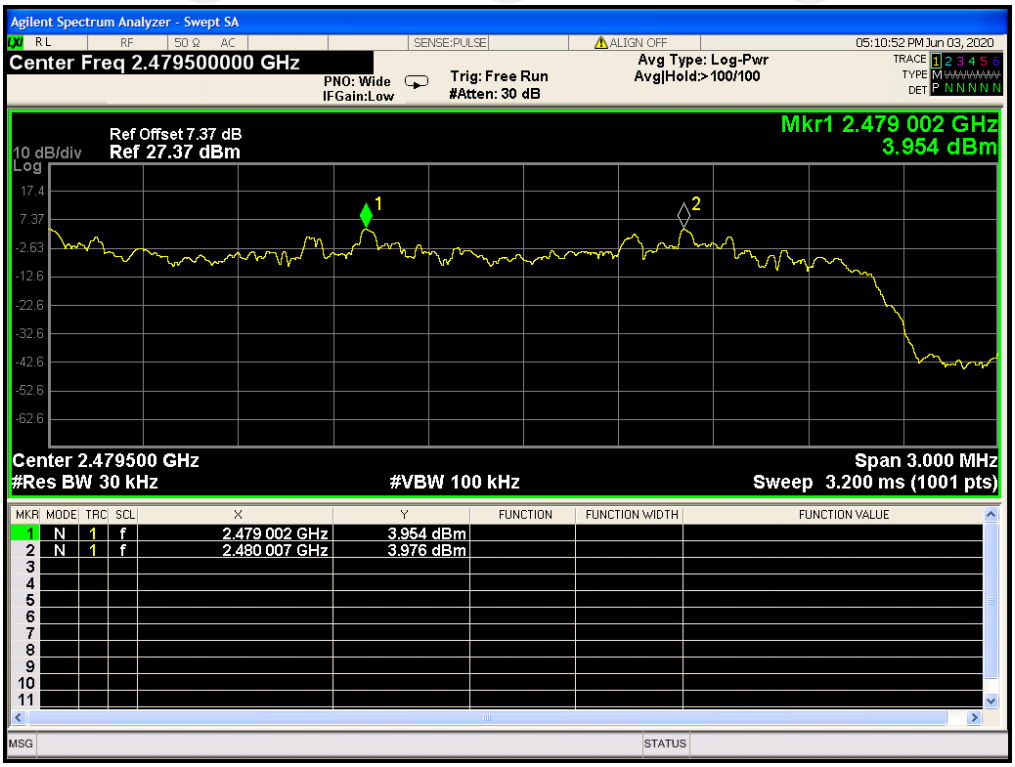
CFS NVNT 3-DH1 2402MHz



CFS NVNT 3-DH1 2441MHz



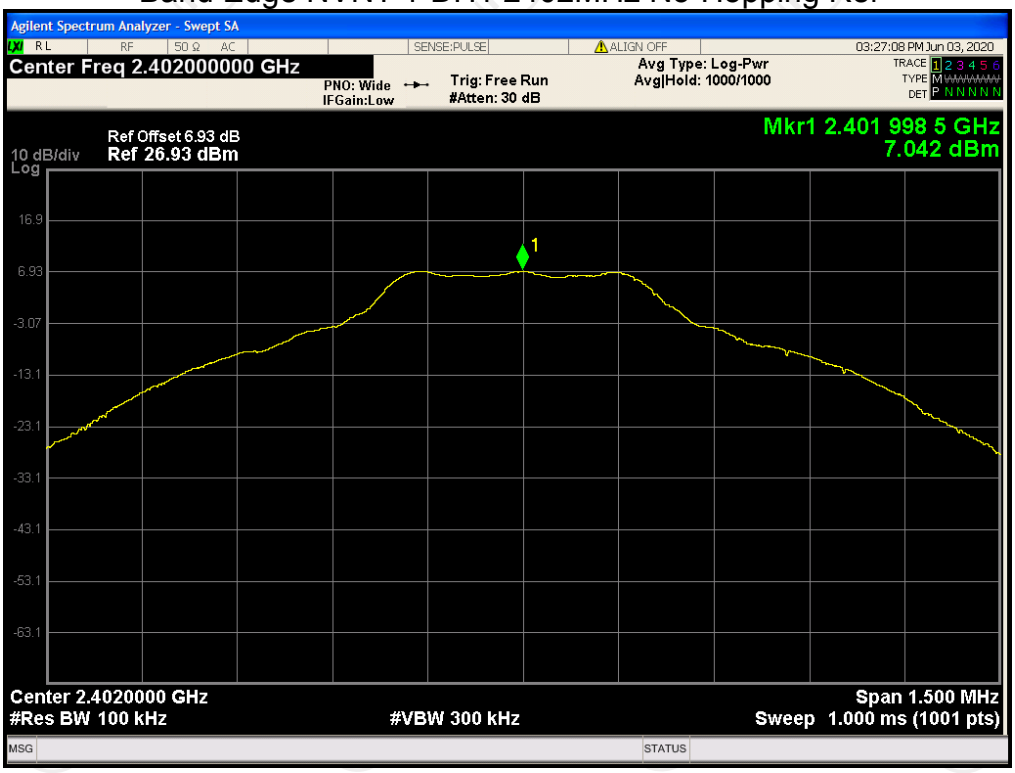
CFS NVNT 3-DH1 2480MHz



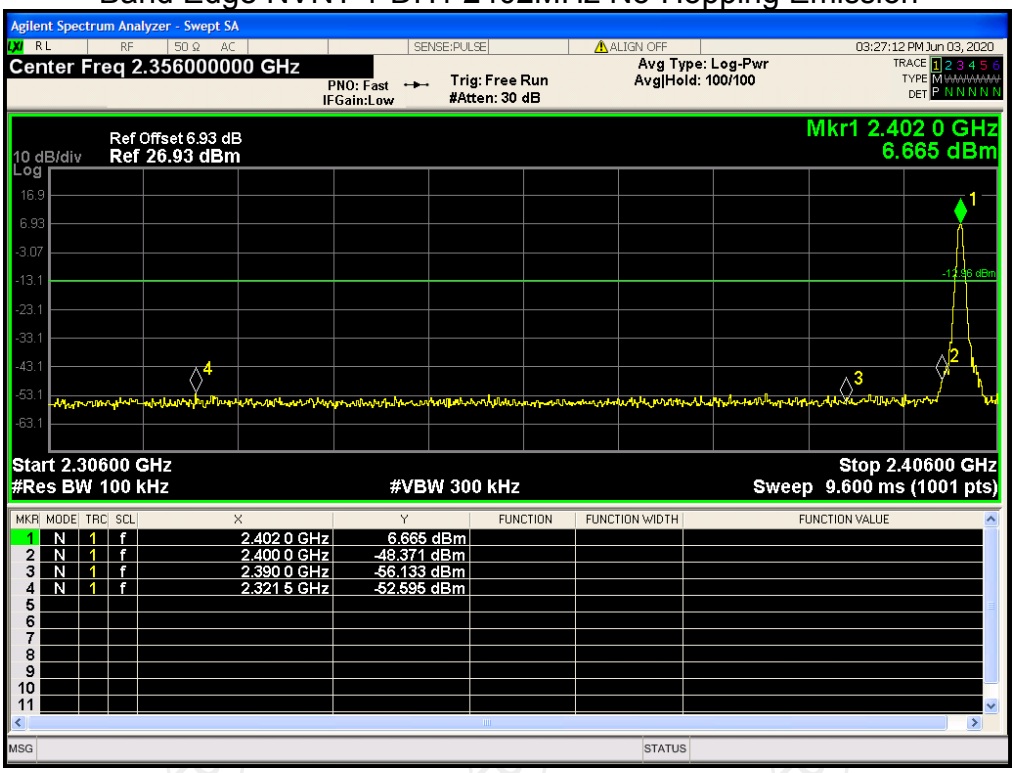
Band Edge

Mode	Frequency (MHz)	Hopping Mode	Max Value (dBc)	Limit (dBc)	Verdict
1-DH1	2402	No-Hopping	-59.63	-20	Pass
1-DH1	2480	No-Hopping	-59.90	-20	Pass
2-DH1	2402	No-Hopping	-56.75	-20	Pass
2-DH1	2480	No-Hopping	-57.10	-20	Pass
3-DH1	2402	No-Hopping	-57.33	-20	Pass
3-DH1	2480	No-Hopping	-57.56	-20	Pass

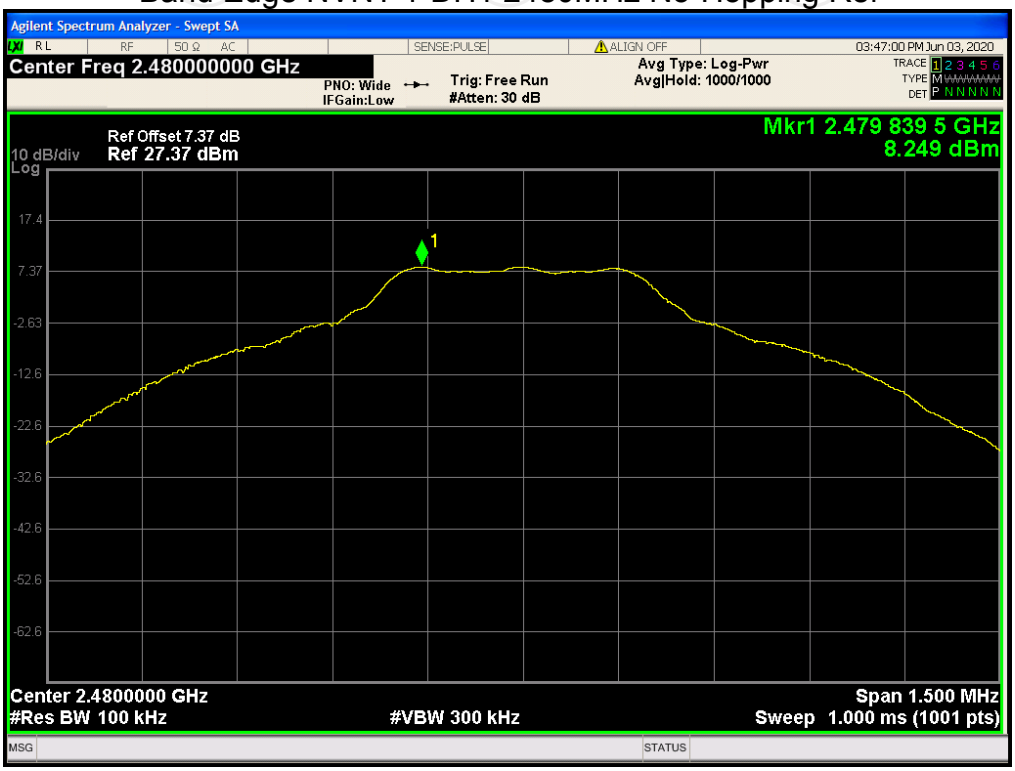
Band Edge NVNT 1-DH1 2402MHz No-Hopping Ref



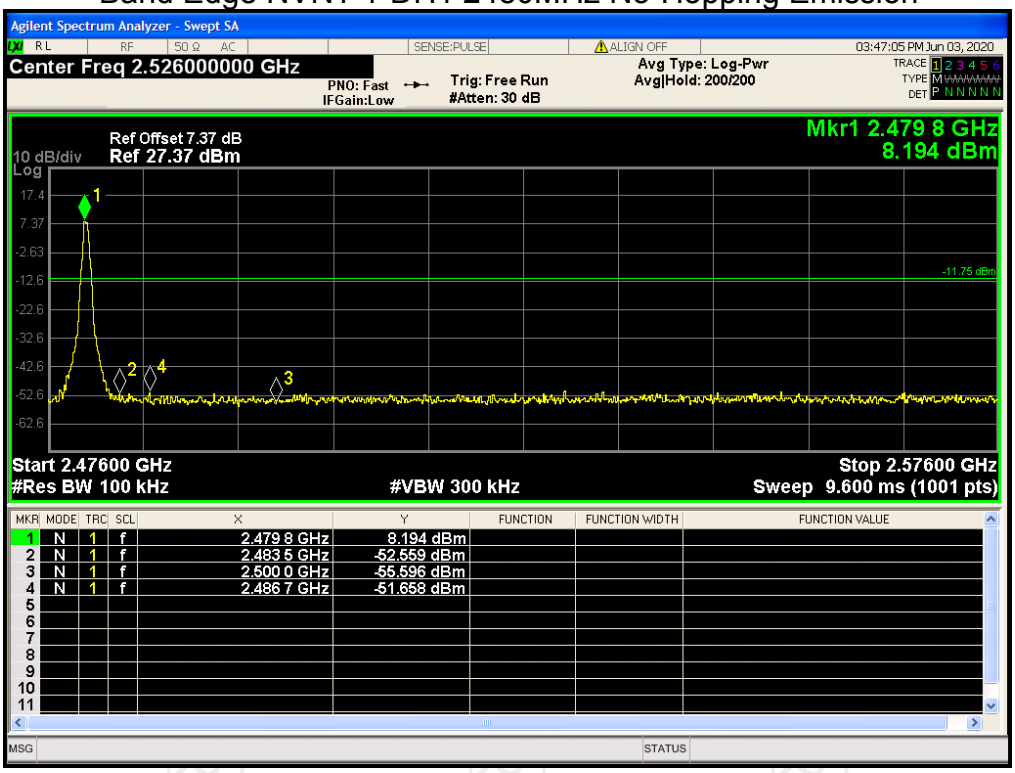
Band Edge NVNT 1-DH1 2402MHz No-Hopping Emission



Band Edge NVNT 1-DH1 2480MHz No-Hopping Ref

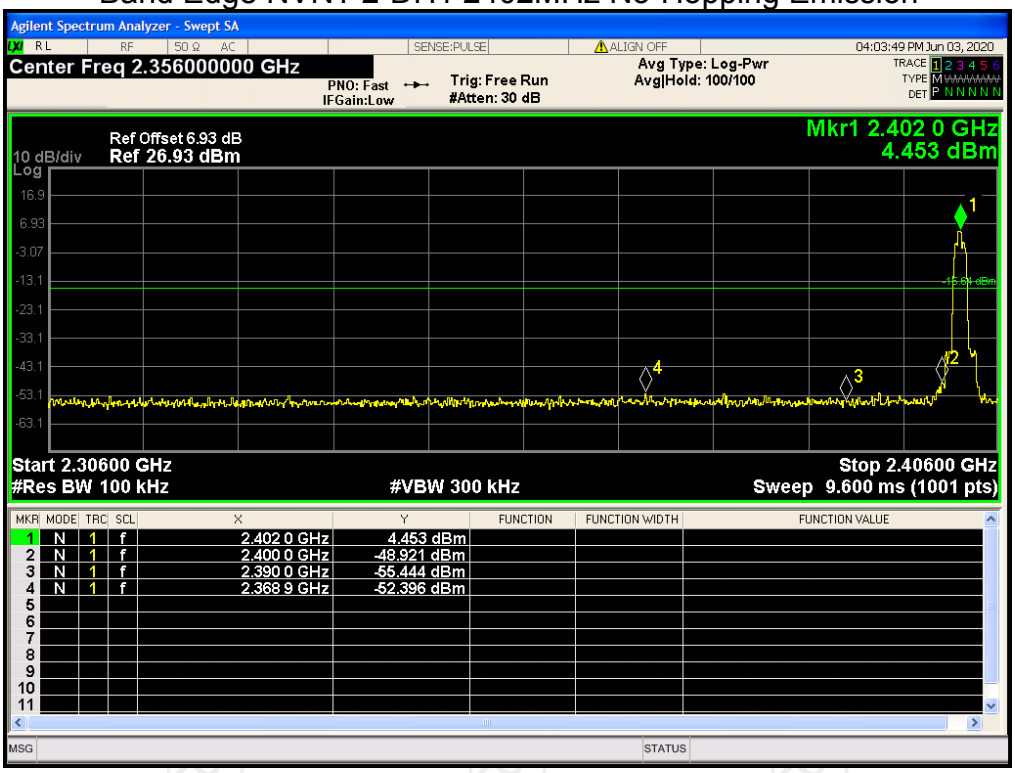


Band Edge NVNT 1-DH1 2480MHz No-Hopping Emission



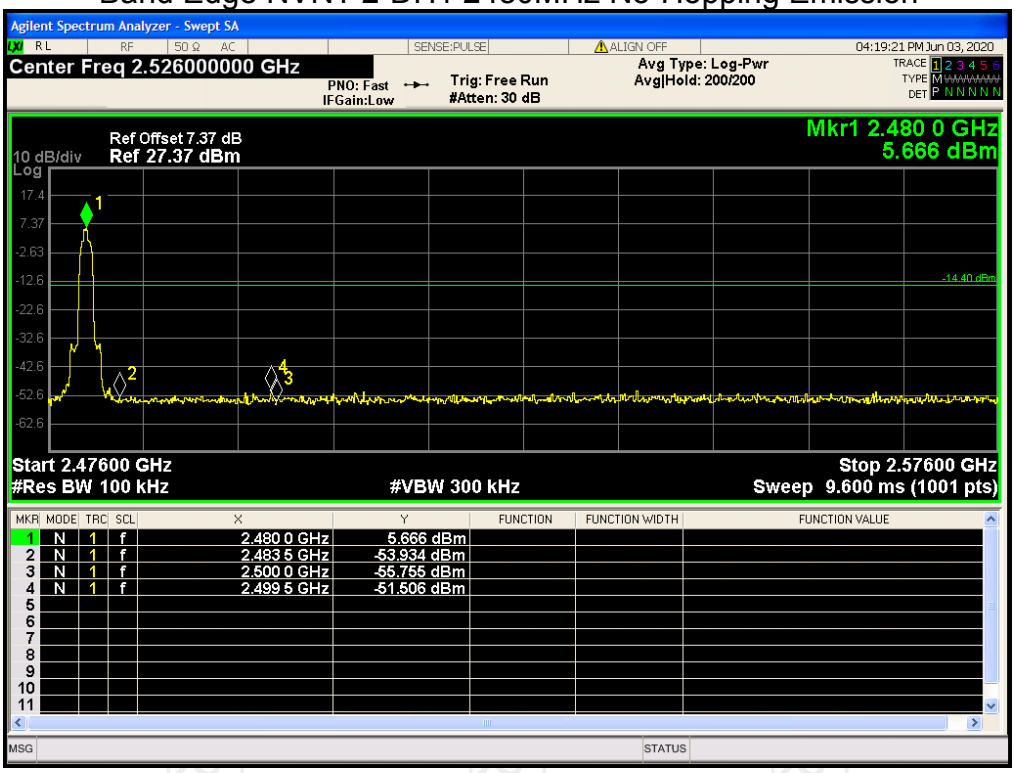
Band Edge NVNT 2-DH1 2402MHz No-Hopping Ref

Band Edge NVNT 2-DH1 2402MHz No-Hopping Emission



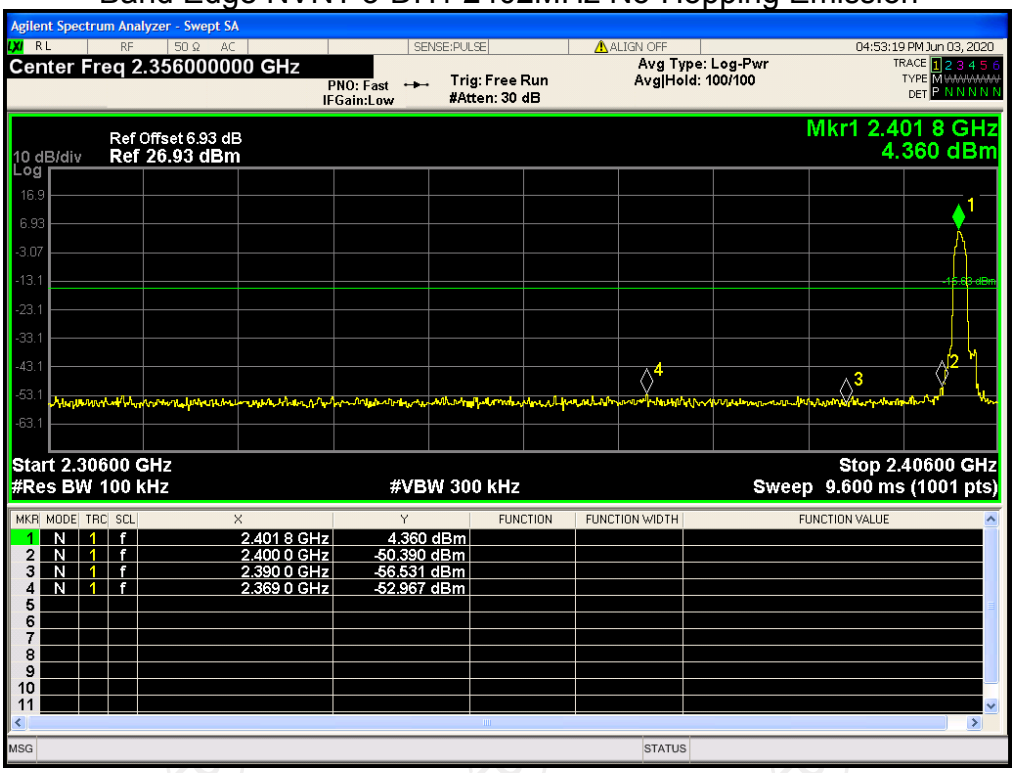
Band Edge NVNT 2-DH1 2480MHz No-Hopping Ref

Band Edge NVNT 2-DH1 2480MHz No-Hopping Emission



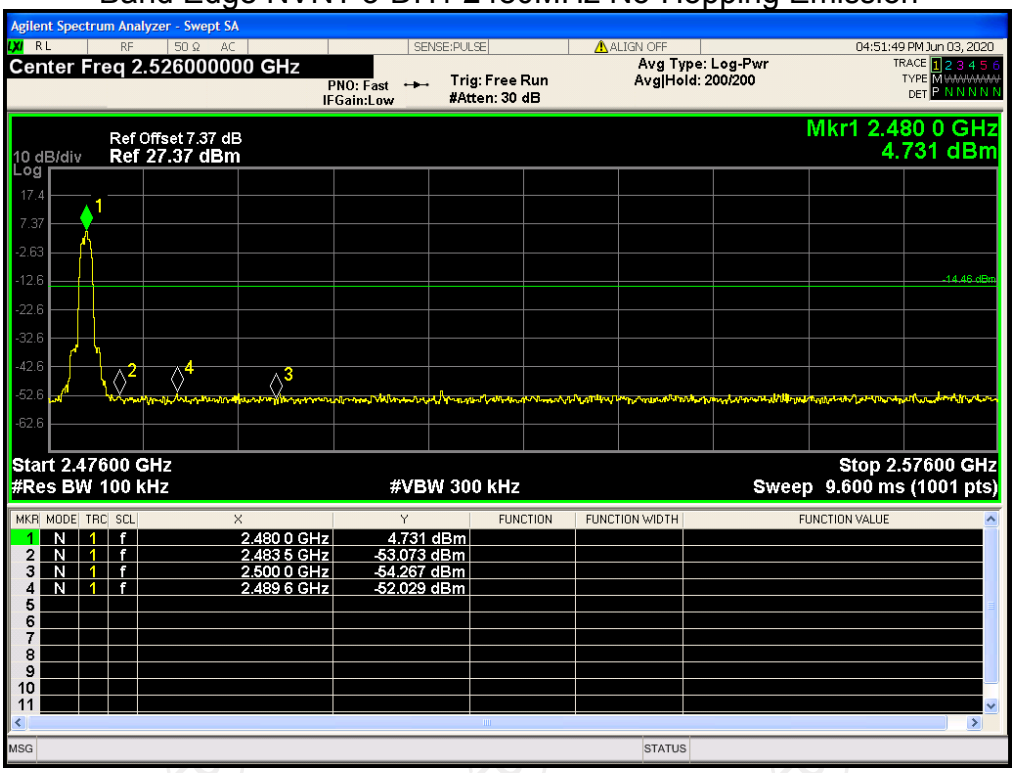
Band Edge NVNT 3-DH1 2402MHz No-Hopping Ref

Band Edge NVNT 3-DH1 2402MHz No-Hopping Emission



Band Edge NVNT 3-DH1 2480MHz No-Hopping Ref

Band Edge NVNT 3-DH1 2480MHz No-Hopping Emission

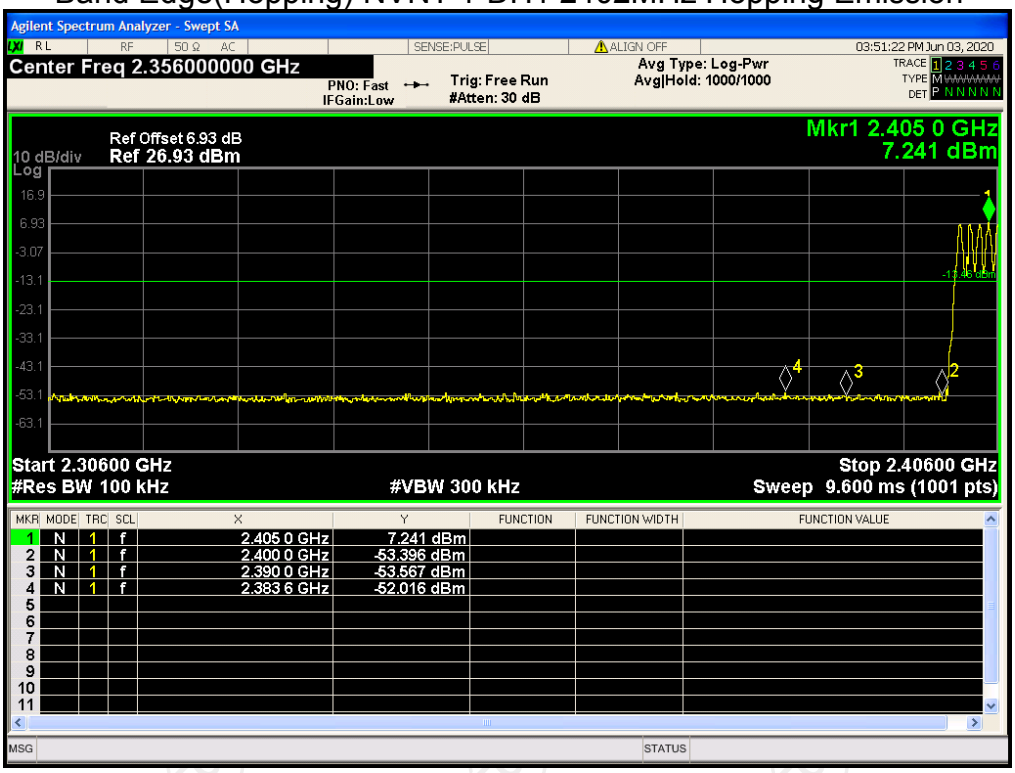


Band Edge(Hopping)

Mode	Frequency (MHz)	Hopping Mode	Max Value (dBc)	Limit (dBc)	Verdict
1-DH1	2402	Hopping	-58.55	-20	Pass
1-DH1	2480	Hopping	-59.25	-20	Pass
2-DH1	2402	Hopping	-55.73	-20	Pass
2-DH1	2480	Hopping	-56.98	-20	Pass
3-DH1	2402	Hopping	-56.63	-20	Pass
3-DH1	2480	Hopping	-56.81	-20	Pass

Band Edge(Hopping) NVNT 1-DH1 2402MHz Hopping Ref

Band Edge(Hopping) NVNT 1-DH1 2402MHz Hopping Emission



Band Edge(Hopping) NVNT 1-DH1 2480MHz Hopping Ref

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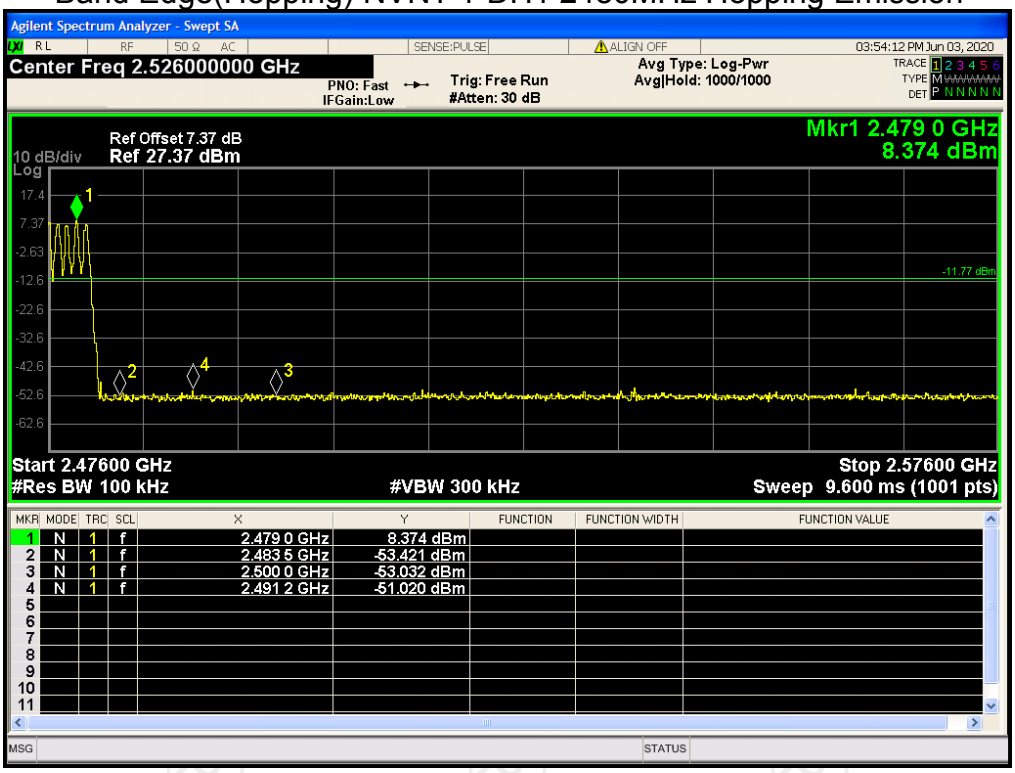
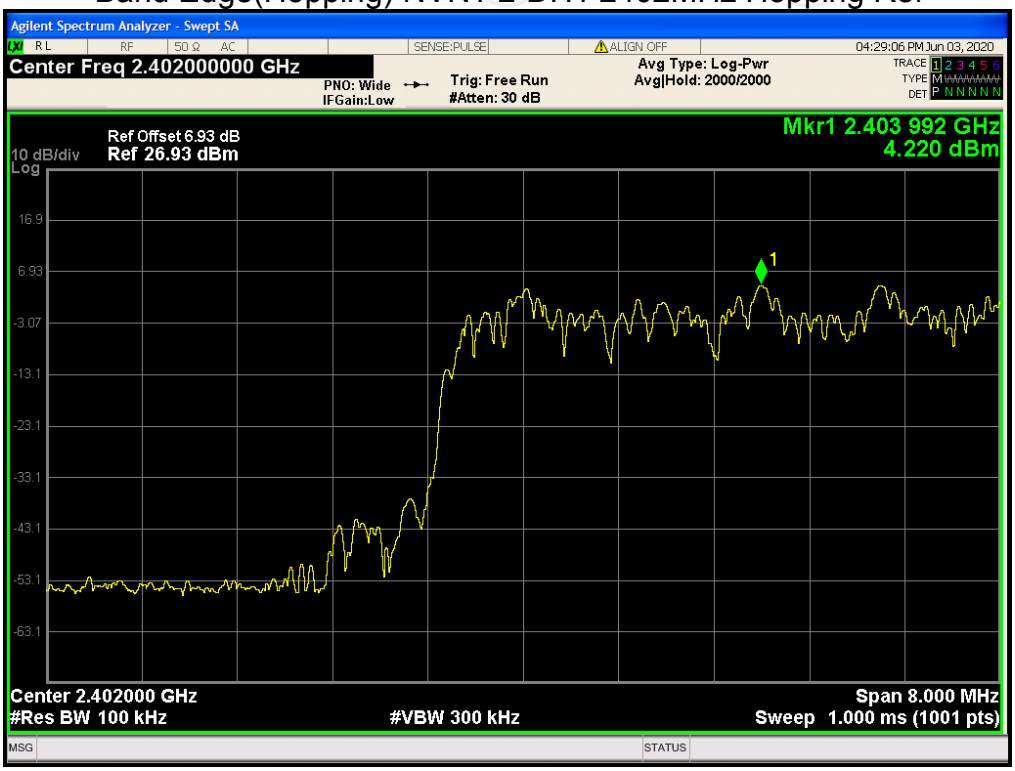
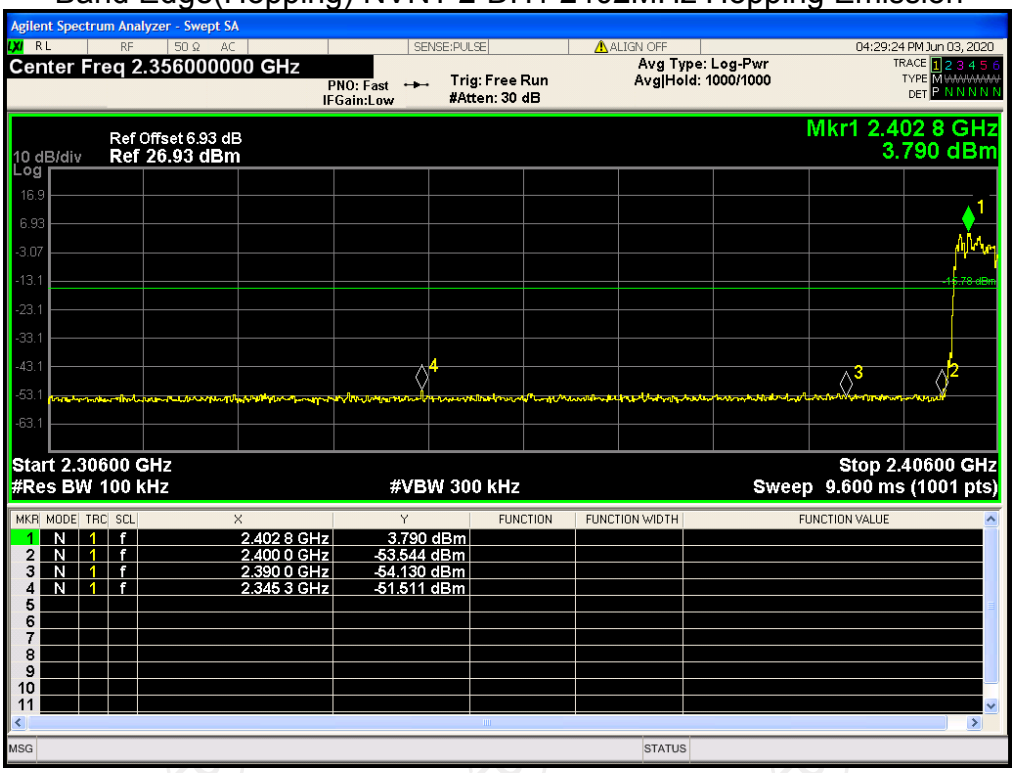
Band Edge(Hopping) NVNT 1-DH1 2480MHz Hopping Emission



Band Edge(Hopping) NVNT 2-DH1 2402MHz Hopping Ref

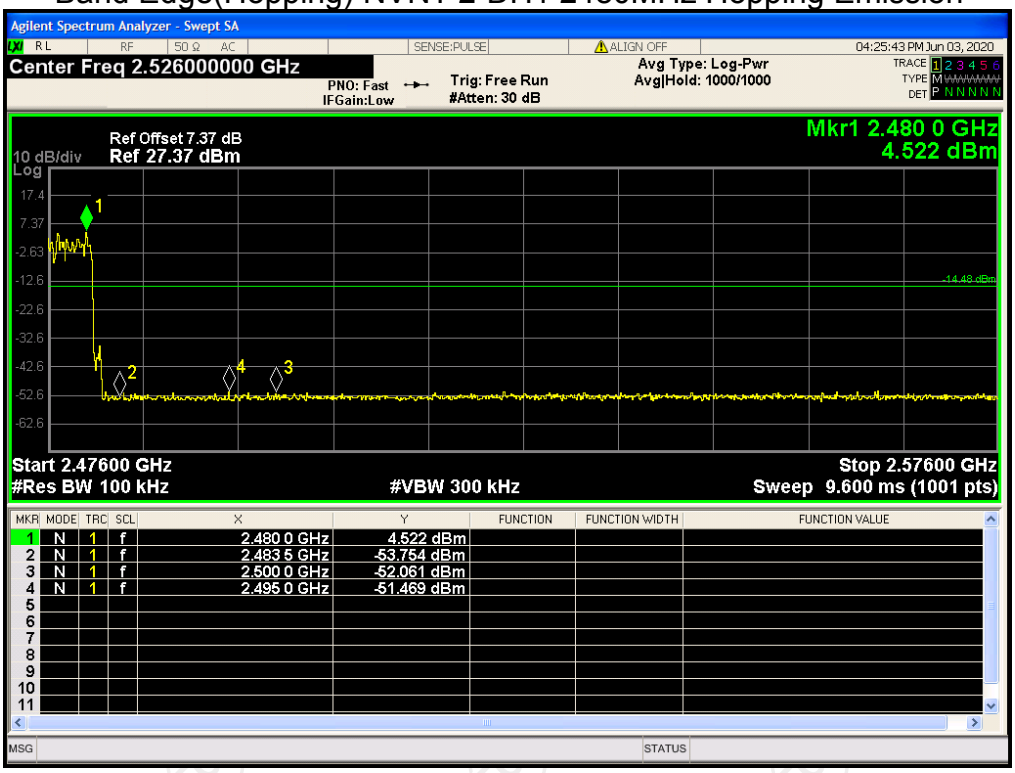


Band Edge(Hopping) NVNT 2-DH1 2402MHz Hopping Emission



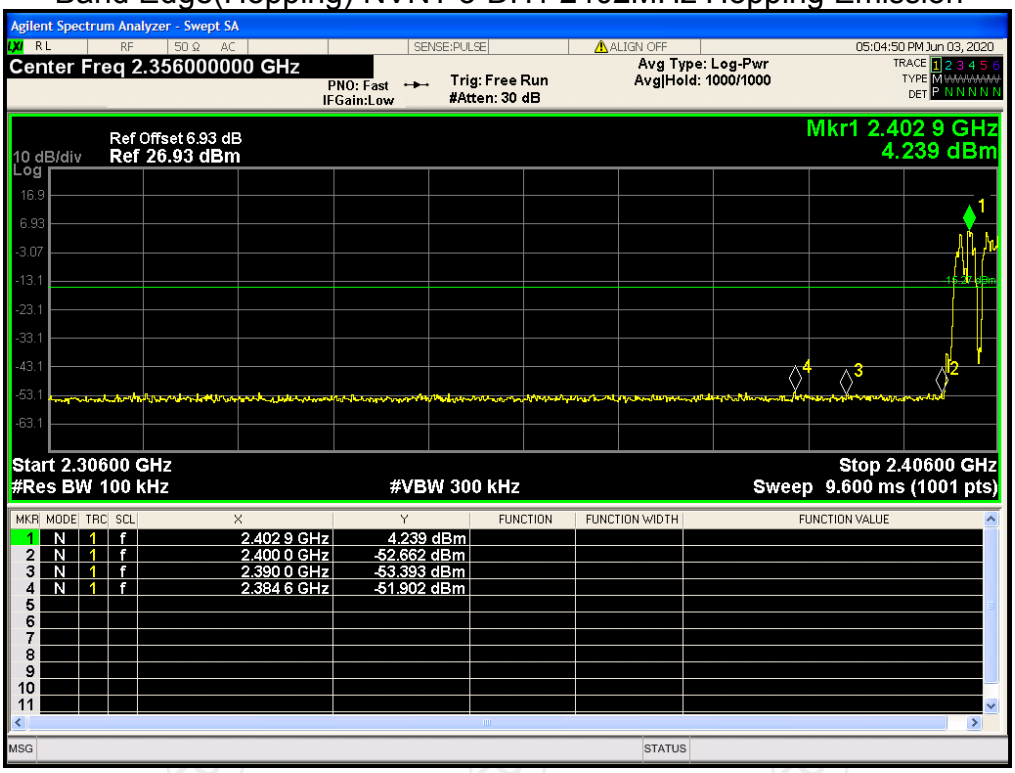
Band Edge(Hopping) NVNT 2-DH1 2480MHz Hopping Ref

Band Edge(Hopping) NVNT 2-DH1 2480MHz Hopping Emission



Band Edge(Hopping) NVNT 3-DH1 2402MHz Hopping Ref

Band Edge(Hopping) NVNT 3-DH1 2402MHz Hopping Emission



Band Edge(Hopping) NVNT 3-DH1 2480MHz Hopping Ref

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